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EFFECTS OF AN ARTIFICIAL DUCTUS ARTERIOSUS ON EXPERIMENTAL CYANOSIS AND ANOXEMIA

ALFRED BLALOCK, M.D.
BALTIMORE

THESE experiments were begun several years ago, at the time that Dr. Helen Taussig and I became interested in the question whether increase of the blood supply to the lungs by the creation of an artificial ductus arteriosus would benefit patients with the tetralogy of Fallot or pulmonary stenosis. It is obvious that it would have been desirable to reproduce experimentally the combination of defects which are found in the tetralogy of Fallot. Since there is no known method by which this can be done, the initial efforts consisted in many attempts to produce pulmonary stenosis of severe degree. These experiments met with little success and will not be described in great detail. It was then decided to attempt to produce unsaturation of the arterial blood by the removal of pulmonary tissue combined with the creation of a pulmonary arteriovenous fistula.

ATTEMPTS TO PRODUCE STENOSIS OF THE PULMONARY ARTERY

Various methods were used in an attempt to produce chronic constriction of the main pulmonary artery. Included among these were (1) use of constricting ligatures of braided silk, (2) constriction by rubber tubes, (3) constriction by bands of ox fascia and (4) use of large silver Goldblatt clamps. Various studies were carried out before and after the application of the constricting devices. These included determinations of the arterial and the mixed venous oxygen and carbon dioxide contents, the oxygen consumption, the cardiac output, the red blood cell count, the hematocrit reading and the venous pressure. No consistent and sustained alterations were found. In some of the animals an artificial patent ductus was created after the constriction of the pulmonary artery, but the results became meaningless when subsequent observation showed that the stenosis of the artery no longer persisted. When a braided silk ligature was used for partial occlusion of the pulmonary artery, the ligature usually cut through the wall of the vessel and the lumen returned to the original size. When rubber

From the Department of Surgery of the Johns Hopkins University School of Medicine and Hospital.

tubing was employed, death generally followed from hemorrhage due to erosion of the wall of the vessel. When a Goldblatt silver clamp was used, the animal usually died because of too great constriction or hemorrhage or accumulation of fluid in the pleural cavity.

The negative results of these experiments should have been and were anticipated in the light of the previous experiences of others. For example, the following sentences contain some of the conclusions of Haggart and Walker[1]: "Until from 52 to 66 per cent of the pulmonary circulation is cut off there is no significant variation in the general circulatory condition of the animal. The point at which failure occurs is sharply defined, since beyond this endpoint a circulatory collapse is precipitated by a minute increase in the arterial obstruction, but if this is not applied no untoward change results." At any rate, it appeared that some other method would have to be used if the effects of an artificial ductus arteriosus were to be tested.

PNEUMONECTOMY AND CREATION OF PULMONARY ARTERIOVENOUS FISTULA

The next procedure which was used consisted in the removal of the entire right lung and the performance of an end to end anastomosis between the proximal end of the right pulmonary artery and the proximal end of a major right pulmonary vein. The blood which was pumped by the right side of the heart to the right pulmonary artery returned to the left side of the heart without being oxygenated. In most of these dogs, polycythemia, arterial unsaturation and cyanosis developed. The following results were obtained in one of the experiments: A comparison of the preoperative values with those obtained three months later shows that the hematocrit reading rose from 48 to 67, the red blood cell count rose from 4,800,000 to 7,200,000 per cubic millimeter, the oxygen content of arterial blood rose from 21 to 23 volumes per cent and the oxygen saturation of arterial blood declined from 95 to 75 per cent. These animals showed an increase in blood volume, which was due to the increase in the volume of red blood corpuscles. Most of the animals were dyspneic on slight exertion, and the mucous membranes were of a reddish blue color.

The alterations in the arterial saturation in these animals were of the order that had been sought, but unfortunately the absence of one entire lung made it difficult or impossible to test the effects of the creation of an artificial ductus arteriosus. It was then decided that parts of one or both lungs should be removed and that unilateral or bilateral pulmonary arteriovenous fistulas should be created. The presence of

1. Haggart, G. E., and Walker, A. M.: The Physiology of Pulmonary Embolism as Disclosed by Quantitative Occlusion of the Pulmonary Artery, Arch. Surg. **6**:764 (May) 1923.

residual pulmonary tissue on both sides would allow one to interrupt the circulation to one of the two sides while the pulmonary artery on this side was being anastomosed to a branch of the aorta.

LIMITED PULMONARY RESECTION COMBINED WITH PULMONARY ARTERIOVENOUS FISTULA

A total of 36 experiments employing pulmonary resection combined with pulmonary arteriovenous fistula were performed. The procedure varied somewhat, but the method used most often consisted at the first operation in the removal of the diaphragmatic and intermediate lobes of the right lung and the performance of an end to end anastomosis

Effect on Arterial Saturation of the Creation of an Artificial Ductus Arteriosus

Days	Hematocrit Reading, %	Arterial Oxygen Content, Vols. %	Arterial Saturation, %
0	56.0	23.8	95.0
3	Diaphragmatic and intermediate lobes of right lung removed; pulmonary arteriovenous fistula created		
25	41.0	18.2	82.5
37	38.3	18.7	82.0
48	Hypertrophied left lower lobe removed; no fistula created		
68	68.8	12.2	46.4
69	69.0	13.2	52.5
69	Artificial ductus between end of subclavian artery and side of left pulmonary artery		
76	51.4	19.0	80.5
83	36.5	17.2	79.5
96	47.5	15.9	72.8
123	37.9	15.1	72.6
164	32.0	12.5	72.4
200	33.2	14.3	76.3
239	39.0	15.3	74.1
277	38.3	15.7	78.8

between the proximal ends of the severed pulmonary artery and vein. The dog has four lobes on the right and three on the left. If the dog survived this initial operation and if the resulting degree of arterial unsaturation was less than was desired, the procedure was repeated on the left side, the lower lobe being removed and the artery and vein being united by sutures. In the 36 experiments, a total of one hundred and eight lobes were removed and fifty-three pulmonary arteriovenous fistulas were created. Most of the animals died during or after the second procedure, in which additional pulmonary tissue was removed and a

second fistula created. An attempt was being made to produce a severe degree of arterial unsaturation, such as is seen in many children with pulmonary stenosis, namely, 60 to 75 per cent unsaturation. It was decided subsequently that a less severe degree of unsaturation would be adequate for the purpose. It is of interest, however, that arterial saturations of 32, 34, 35 and 42 per cent were produced in 4 of the experiments, but the animals died before or during an attempt to create an artificial ductus arteriosus.

There were only 6 experiments in which a rather pronounced degree of oxygen unsaturation of arterial blood has been produced and in which an artificial ductus arteriosus has been successfully created. Only a slight increase in arterial oxygen saturation occurred following the making of the artificial ductus in 2 of the animals. There was a significant elevation of the arterial saturation in the remaining 4 animals. The proximal end of the divided left subclavian artery was anastomosed to the side of the left pulmonary artery in 4 of the experiments. In the remaining 2, the end of the innominate artery was anastomosed to the side of the right pulmonary artery. Some of the details of 1 of the experiments are given in the table. The arterial oxygen saturation rose from 52 to 80 per cent following the creation of an artificial ductus, and the arterial oxygen capacity declined from 27 to 22 volumes per hundred cubic centimeters.

COMMENT

Cyanosis is due to the presence of reduced hemoglobin in the circulating blood. Lundsgaard and Van Slyke [2] showed that there are four important factors in the production of cyanosis: (1) the total hemoglobin content, (2) the degree of oxygen unsaturation of the arterial blood coming from aerated pulmonary areas, (3) the proportion of blood passing from the right side of the heart to the left through unaerated channels and (4) the oxygen consumption in the capillaries.

In the experiments reported on here, in which pulmonary tissue was removed and a pulmonary arteriovenous fistula created, it seems that the main reason for the arterial unsaturation is the return of unoxygenated blood through the fistula directly to the left side of the heart. The total hemoglobin was not greatly increased in these experiments, and there is no reason to believe that the degree of oxygen unsaturation of the arterial blood coming from the remaining pulmonary tissue or

2. Lundsgaard, C., and Van Slyke, D. D.: Cyanosis, Medicine **2**:1 (Feb.) 1923.

the oxygen consumption in the capillaries of the body was grossly abnormal. The relationships in patients with the tetralogy of Fallot are complex, and there are a number of reasons for the arterial unsaturation and the resulting cyanosis. These were discussed in a recent paper by Dr. Taussig and me.[3] The fact that there is a defect in the interventricular septum and that the aorta overrides the septum results in the passage of some unaerated blood into the aorta. It is mainly in this respect that the experimental condition here reported resembles the tetralogy of Fallot.

In these experiments the creation of an artificial ductus arteriosus was followed in most instances by an increase in the oxygen saturation of the arterial blood. This increase was due to the passage of a greater quantity of blood which was not fully oxygenated through the pulmonary capillaries. If the cardiac output remained unaltered, a greater number of red blood corpuscles were exposed to the inspired air in a given unit of time. Although this experimentally produced condition is different from that seen in the patient with the tetralogy of Fallot, the results of these studies strengthened the impression of Dr. Taussig that the patient with pulmonary stenosis would be improved if the pulmonary blood flow were increased and led to the development of the operation [3] as now performed on patients with pulmonary stenosis or atresia.

SUMMARY

These experimental studies were performed in an effort to determine whether the creation of an artificial ductus arteriosus would be helpful in the treatment of pulmonary stenosis or atresia in patients. Attempts to produce the desired degree of pulmonary stenosis were unsuccessful. Unilateral pneumonectomy and the anastomosis of the proximal ends of the pulmonary artery and vein resulted in a high degree of oxygen unsaturation of arterial blood, but this preparation was unsatisfactory for testing the effects of an artificial ductus arteriosus. The removal of lobes of one or both lungs and the anastomosis of the severed proximal ends of the pulmonary artery and vein usually resulted in a high degree of arterial oxygen unsaturation of arterial blood, but this preparation was unsatisfactory for testing the effects of an artificial ductus arteriosus. The removal of lobes of one or both lungs and the

3. Blalock, A., and Taussig, H. B.: The Surgical Treatment of Malformations of the Heart in Which There Is Pulmonary Stenosis or Pulmonary Atresia, J. A. M. A. **128**:188 (May 19) 1945.

anastomosis of the severed proximal ends of the pulmonary artery and vein usually resulted in a high degree of arterial oxygen unsaturation because some venous blood returned to the heart without having passed through pulmonary capillaries. The creation of an artificial ductus arteriosus under these conditions usually resulted in an increase in the oxygen saturation of the arterial blood. The possible relationship of these observations to the treatment of pulmonary stenosis in patients is discussed.

Dr. Helen Taussig gave helpful advice.

SUBMUCOSAL LIPOMAS OF THE STOMACH

A Review of the Literature and Report of a Case Associated with Carcinoma

ORLAND B. SCOTT, M.D.
AND
ALEXANDER BRUNSCHWIG, M.D.
CHICAGO

IN the last decade there has been an increasing interest in the problems associated with the benign tumors of the stomach. In the past such lesions have been considered as relatively rare. Although reports now indicate that they occur with greater frequency than previously supposed [1] a few of the types of benign tumors may still be considered as rare, and, of these, one of the least is the submucosal lipoma.

In 1893 Tilger [2] emphasized the rarity of this tumor, when he reported from a series of 3,500 autopsies 14 benign gastric tumors, 2 of which were submucosal lipomas. Eliason and Wright [3] in summarizing 610 collected and personal cases of benign gastric tumors, noted 30 lipomas of the stomach, including 1 from their own cases. Stewart [4] found no submucosal lipomas in a series of 11,000 autopsies. Minnes and Geschickter [5] mentioned 32 cases in a series of 981 collected and personal cases of benign gastric tumors. Rumold [6] in a review of the literature from 1835 to 1940 was able to find 32 cases and added 1 case of his own, bringing the total to 33. Since then, several cases have been reported. We wish to review briefly these recent cases and to

From the Department of Surgery, University of Chicago, The School of Medicine.

This report was facilitated by a grant-in-aid for the study of neoplastic diseases, given by Mr. Hill Blackett, of Chicago.

1. Dudley, G. S.; Miscall, L., and Morse, S. F.: Benign Tumors of the Stomach, Arch. Surg. **45**:702 (Nov.) 1942. Dewey, E. B.: Benign Tumors of the Stomach, Am. J. Surg. **65**:233 (Aug.) 1944.

2. Tilger, A.: Ueber primäres Magensarcom, Virchows Arch. f. path. Anat. **133**:183, 1893.

3. Eliason, E. L., and Wright, V. W. M.: Benign Tumors of the Stomach, Surg., Gynéc. & Obst. **41**:461, 1925.

4. Stewart, M. J.: Observations on the Relation of Malignant Diseases to Benign Tumors of the Intestinal Tract, Brit. M. J. **2**:567, 1929.

5. Minnes, J. F., and Geschickter, C. F.: Benign Tumors of the Stomach, Am. J. Cancer **28**:130, 1936.

6. Rumold, M. H.: Submucous Lipomas of the Stomach, Surgery **10**:242, 1941.

report a case of a submucous lipoma of the pylorus associated with an infiltrative adenocarcinoma. In doing so, we have reproduced Rumold's [6] tabulation of cases and have added to it the more recent cases, including our own (see the table). Because the descriptive data were insufficient, this does not include the 3 cases mentioned by Bouvier.[7]

Summary of Cases of Submucosal Lipomas of the Stomach

Case	Year	Author	Sex	Age, Yr.	Discovery	Size	Clinical Features
1	1835-1842	Cruveilhier.....	..	..	Autopsy	"Almond"	
2	1863	Virchows.....	M	..	Autopsy	"Hazelnut"	
3	1889	Murray.....	..	64	Autopsy		
4	1893	Tilger.....	..	High age	Autopsy	"Hazelnut"	
5	1893	Tilger.....	..	High age	Autopsy	"Hazelnut"	
6	1905	Benaky.....	M	65	Autopsy	6 by 3, 5 by 2 cm.	
7	1905	Fischer.....	F	37	Resection	"Walnut"	Pains in umbilical region; gastric juice normal
8	1906	Hellstrom.....	M	77	Autopsy	"Hazelnut"	Free from symptoms
9	1911	Westenhoeffer.	..	..	Autopsy		
10	1912	Randisi.....	M	65	Resection	"Triangular prismatic tumor"	Epigastric pains; vomiting; emaciation of 28 months' duration
11	1922	Verger and Massias	F	58	Autopsy	"Hazelnut"	Anorexia; nausea; diarrhea; emaciation; cachexia
12	1924	Nahmmacher..	F	65	Autopsy	8 by 3, 5 by 3 cm.	
13	1925	Eliason and Wright	M	52	Autopsy	Solitary tumor in fundus	
14	1926	Bianchi.....	F	57	Autopsy	.....	Vomited for 12 mos.
15	1926	Spitzmuller....	M	69	Resection	"Tangerine"	Palpable tumor; blood in stools; pain after meals
16	1928	Weicker.....	M	60	Resection	"Small apple"	Pains after meals, sometimes vomiting; achylia; roentgenographic defect; emaciation
17	1929	White and Judd	F	59	Resection	5.5 by 3, 3 by 2.3 cm.	Attacks of fatigue; roentgenographic defect; hemorrhage; tarry stools
18	1930	Neumann.....	F	62	Resection	15 by 4 cm.	Mild eructations; roentgenogram reveals tumor in cardia
19	1931	Comfort.....	M	67	Autopsy	9.5 by 4.5 cm.	
20	1931	Comfort.....	F	65	Autopsy	8 mm. diameter	
21	1931	Comfort.....	M	74	Autopsy	1 by 2 by 3.5	
22	1933	Mandl and Vogl	M	43	Excision	"Pedicled tumor, larger than nut"	History of ulcers
23	1933	Pansdorf and Determann	F	65	Resection	Broad-based 1 cm. in diameter	Weber's test positive in feces; roentgenogram reveals benign tumor
24	1944	Melchior.....	M	57	Resection	"Oscillating tumor; size of cherry"	Weber's test positive; symptoms simulating cholecystitis
25	1934	Santy.....	F	40	Resection	"Tangerine"	Anemia; pains after food; vomiting; Weber's test of feces positive

7. Bouvier, E.: Ueber die benignen Tumoren des Magendarmtraktes, Arch. f. klin. Chir. **131**:162, 1924.

Summary of Cases of Submucosal Lipomas of the Stomach—Continued

Case	Year	Author	Sex	Age, Yr.	Discovery	Size	Clinical Features
26	1935	Glass.....	M	30	Resection	"Broad-based tumor size of fist"	Epigastric pain; black stool; Weber's test positive in feces
27	1935	Kirschbaum, J.D.: Ann. Surg. **101**: 734, 1935	F	75	Autopsy		
28	1935	Troisier.....	..	..	Autopsy	"Ten tumors; largest size almond"	Anemia, profuse hemorrhage
29	1936	Kentorovitch..	F	29	Resection	"Size of kidney"	Nausea and vomiting; roentgenogram showed benign tumor
30	1937	Metivet.....	M	69	Resection	20 cm. in diameter	Blood in stools; roentgenogram showed probably benign tumor
31	1938	Redell.....	F	33	Resection	167 Gm.; "twice the size of a hen's egg"	Black stools; anemia; Weber's test of stools positive
32	1938	Garre, Garelik and Ciarlo	M	50	Resection	9 by 4 cm.	Eructions; abundant hematemesis
33	1939	Jorns, G.: Chirurg **11**: 840, 1939	M	40	Resection	Oscillating; 3 by 3 cm.	18 year history of distress with fulness after meals; roentgenogram showed constant filling defect; blood in stools
34	1940	Knetsch, A.: Röntgenpraxis **12**: 159, 1940	M	43	Resection	"Walnut sized"	Epigastric fulness, nausea and emesis after meals; roentgenogram showed constant filling defect in angulus
35	1940	Rumold.....	F	47	Resection	7.5 by 5.5 by 5 cm.	Eructations; blood in stools; nausea; vomiting; anemia; achlorhydria
36	1944	Sobezyk.....	F	54	Excision	7 by 2 by 3 cm.	Epigastric pain; anemia; tarry stools; palpable mass; roentgenogram showed filling defect
37	1942	Cattell.....	F	37	Resection	6 cm. in diameter	Fatigue and epigastric fulness after eating; hematemesis; tarry stools; roentgenogram showed filling defect
38	1942	Daza and Zuniga	F	43	Resection	3 cm. in diameter	Gastric distress periodic since infancy; epigastric fulness and burning after meals; hypochlorhydria; tarry stools; roentgenogram showed filling defect
39	1945	Scott and Brunschwig	M	59	Resection	1.5 by 2 cm.	Pain in epigastrium; vomiting; loss of weight; achlorhydria; roentgenograms showed obstructive lesion in pylorus

REPORT OF A CASE

F. O., a 59 year old Italian man, was admitted to the University of Chicago Clinics on June 27, 1945, complaining of epigastric pain, of three months' duration, associated with vomiting and a 15 pound (6.8 Kg.) loss of weight.

Inquiry revealed that he had a similar episode in 1941. Roentgenograms at that time were said to show gastric ulcer. The patient was treated with powders, milk and cream, and within two months his symptoms had disappeared. In 1942

and 1943 he had recurrence of symptoms, and on each occasion complete remission of symptoms was obtained with medical management. The last episode, which led to his admission to the hospital, began in March 1945, at which time he began to have epigastric pain, which characteristically appeared about two hours after meals and often awakened him at night. Occasionally he would vomit large volumes of a foul gray material. Relief from symptoms could be obtained by

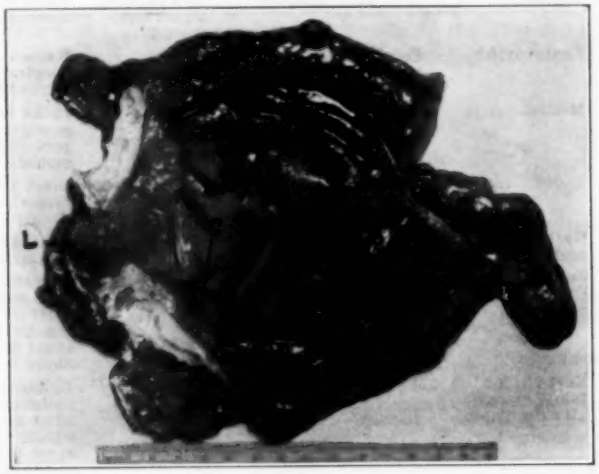

Fig. 1.—Surgical specimen consisting of lower portion of stomach opened along greater curvature and showing *C*, infiltrating carcinoma (bisected), and *L*, sessile submucosal lipoma distal to the neoplasm.

Fig. 2.—Cut edge of specimen shown in figure 1. *L*, cut surface of submucosal lipoma covered by intact gastric mucosa; *C*, cut edge of carcinoma in pyloric region.

belching or emesis or from the use of powders and milk and cream. There was no history of hematemesis or melena.

Physical examination revealed a chronically ill patient, who was having moderate epigastric distress. There was mild tenderness and a sense of resistance

to palpation in the epigastrium. Visible gastric peristalses were noted. The examination was otherwise noncontributory. Examinations of the blood and urine, including studies of blood chemistry, gave essentially normal results. Achlorhydria was demonstrated by a histamine test. Gastroduodenal roentgenologic studies were reported as follows: "On fluoroscopic examination the esophagus appeared normal. An obstructive lesion was present in the pyloric region for 3 to 4 cm. proximal to the duodenal bulb. This area was so narrow that barium sulfate was forced through only with great difficulty and in insufficient quantity to visualize the particular area during the passage of the barium. The duodenal bulb appeared normal. The impression was a constricting lesion of the pylorus causing severe obstruction, presumably due to carcinoma.

"Gastroscopic examination revealed an ulcerating polypoid mass extending as far as the angulus and hidden in the prepyloric area. The impression was a gastric carcinoma."

On July 3, 1945 the abdomen was opened through a high midline incision. An infiltrating lesion was palpated in the prepyloric region, and at the lower portion there seemed to be a boggy mass within the stomach and protruding into the duodenum for about 2 cm. The stomach was mobilized, and a partial gastrectomy with a Polyá type of posterior gastrojejunostomy was done. Recovery was uneventful, and the patient was discharged on the seventeenth postoperative day.

The report of the pathologic examination was as follows: The specimen consists of the distal two thirds of the stomach, measuring 12 and 15 cm. along the lesser and greater curvatures respectively, and a small piece of attached mesocolon. The wall of the stomach seems diffusely thickened and is covered with small hemorrhagic spots. The pyloric end is thickened and indurated, and when this area is cut through a firm, gray-white tissue is encountered. Inspection of the mucosal surface reveals in the prepyloric region a flat shallow ulcer about 5 cm. wide in its greatest diameter. Beyond the lower margin of this ulcer and protruding into the pylorus is a soft sessile mass. This measures about 1.5 cm. in diameter and projects for about 2 cm. into the lumen, so that it occupies almost the entire pyloric canal. Section through this mass shows it to consist of fatty tissue (figs. 1 and 2).

"Microscopic examination of tissue from the ulcerated region reveals groups and strands of malignant epithelial cells infiltrating throughout the muscularis. Acinar formation is common. A section of the mass within the pylorus shows it to consist entirely of mature adipose tissue, which lies just beneath the mucosa. The muscularis at the base of this lesion is infiltrated by carcinoma. The pathologic diagnosis was infiltrative adenocarcinoma of the stomach and submucosal lipoma of the pylorus."

COMMENT

The cause of the lipomas of the intestinal tract remains unknown. Some authors have suggested the possibility of congenital influences since a familial pattern was noted by Rumold [6] in his case of submucous lipoma of the stomach in a patient who had a brother, a sister and two nephews, all of whom had lipomas of the extremities. Daza and Zuniga [8] cited a patient who had periodic episodes of gastric distress from infancy. In addition to a submucosal lipoma of the stomach, she had a lipoma in the right lumbar region. The sex incidence is apparently

8. Daza and Zuniga: Lipom submuco del antro, herniado al duodeno, Rev. méd. de Chile **70**:799, 1942.

equal, and in the 39 case records now available the age incidence varies from 29 to 77 years.

The lipomas of the stomach may be either subserosal or submucosal and may be single or multiple. The submucosal types vary from a few millimeters to several centimeters in diameter and may be sessile or pedunculated. Cattell [9] recorded an unusual instance in which the tumor projected through the gastric wall along the course of vessels, producing a dumbbell-shaped mass. Although their position is variable, they often occur in the region of the pylorus and may produce obstructive symptoms. Overlying the tumor the mucosa is usually smooth, but ulceration is not uncommon. Schindler [10] found that a fairly constant feature of submucosal tumors is the stretching of adjacent rugae so that they appear to bridge the space between the top of the tumor and the surrounding mucosa. Grossly and microscopically these tumors have the characteristics of adipose tissue, with some degree of lobulation.

The clinical picture of the submucosal lipomas of the stomach is variable but not unlike that of other benign gastric tumors. Of the 39 cases now available for study, 22 were operative cases and 17 were reported from autopsies. Clinical data are available on only 2 of the cases brought to autopsy. Hellstrom [11] reported 1 patient as having been free from symptoms. Several of the clinical aspects of the 22 operative cases warrant discussion. Hemorrhage, either severe or of a chronic low grade type, was noted in 15 instances. Thirteen of the patients complained of pain or of a sense of fulness, and in 10 cases nausea and vomiting were prominent features. Obstructive symptoms may occur, depending on the location of the lesion. In our own case, the lipoma occupied almost the entire pyloric canal. Daza and Zuniga [8] reported a case of submucosal lipoma of the antrum which herniated into the duodenum. In only 2 of the recorded cases was a tumor palpable (Spitzmuller [12] and Sobezyk [13]).

The preoperative diagnosis of benign gastric tumors can often be made by roentgenographic and gastroscopic examinations. As pointed out by Moore,[14] there are certain roentgenologic signs that are suggestive of benign tumors.

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9. Cattell, R. B.: Lipoma of the Stomach Causing Hemorrhage, Lahey Clin. Bull. **3**:34, 1942.

10. Schindler, R.; Sandweiss, D. J., and Mintz, I. L.: Benign Submucosal Tumors of the Stomach: Gastroscopic Study, Am. J. Digest. Dis. **9**:289, 1942.

11. Hellstrom, N.: Kasuistische Beiträge zur Kenntnis des Intestinallipoms, Deutsche Ztschr. f. Chir. **84**:488, 1906.

12. Spitzmuller, W.: Ein Fall von Magenlipom, Wien. klin. Wchnschr. **39**:538, 1936.

13. Sobezyk, P.: Benign Tumors and Ulcers with Reference to Submucous Lipomas, Zentralbl. f. Chir. **68**:408, 1941.

1. They produce a filling defect that is well circumscribed and punched out in appearance.

2. The filling defect is usually on the gastric walls, leaving the curvature regular and pliant.

3. While the rugae are often obliterated in the immediate area of inflammatory or malignant lesions, the rugae surrounding a benign tumor are nearly normal in their arrangement and distribution.

4. They cause little or no disturbance in peristalsis, and retention is uncommon except when the lesion is at or near the pylorus.

5. They do not reveal a niche, nor is there any incisura or evidence of spasm.

6. They are rarely sufficiently large to be palpated.

Schindler [10] emphasized the gastroscopic appearance of benign submucosal tumors. He stated that there is "one sign not compatible with a mucosal tumor and permitting the diagnosis of a submucosal tumor, namely, the stretching of a mucosal fold from the surrounding mucosa up to the surface of the tumor, apparently bridging the space between the top of the tumor and the level of the surrounding mucosa." Both Schindler [10] and Rumold [6] have published excellent photographs which demonstrate this characteristic.

The treatment of the submucosal lipomas of the stomach does not differ from that of the other benign gastric tumors. Although local excision may suffice, Rumold emphasized that a portion of the involved gastric wall should be excised to avoid the possibility of recurrence.

The occurrence of both carcinoma and lipoma in the stomach, described by us, is coincidental, as submucosal lipoma is to be regarded neither as a premalignant condition nor as evidence of carcinogenic factors in operation.

SUMMARY

A brief review of the literature has been made, and 6 cases of submucosal lipoma of the stomach have been added to Rumold's tabulation of cases, bringing the total number of reported cases to 39. This includes our own case, in which the lipoma was associated with an adenocarcinoma.

The clinical and pathologic aspects of the submucosal lipomas of the stomach are discussed.

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14. Moore, A. B.: A Roentgenologic Study of Benign Tumors of the Stomach, Am. J. Roentgenol. **11**:61, 1924.

A BASIS FOR SYMPATHECTOMY FOR CANCER OF THE CERVIX UTERI

A. DE SOUSA PEREIRA, M.D.
OPORTO, PORTUGAL

IN RECENT years several attempts have been made to relieve pain in certain cancerous diseases through action on the sympathetic nervous system. By blocking the sympathetic pathways with an anesthetic solution or by surgical interruption, the fibers conducting painful sensations arising in the area involved in the neoplasia are interrupted and the painful stimulations originated in the tumoral area cannot reach the cerebrospinal centers. In this way can be relieved the visceral pain of tumors located in such organs as the uterus, stomach, pancreas and breast. One must remember, however, that the sympathetic approach relieves pain only in the region whose sympathetic innervation has been interrupted; if the tumor grows and invades the adjacent organs beyond the area anesthetized by section of the sympathetic innervation, the painful sensations will reappear. This is true also if the tumor keeps within the anesthetized visceral area but a metastasis develops in a distant region, where a new neoplastic focus will be a point at which new sensations of pain may arise. The results obtained by certain authors (Leriche [1]; Greenhill [2]) and by me and my associates in the treatment of visceral pain due to cancer clearly show that it is possible, by action on the sympathetic system, to relieve the pain of these unhappy patients in certain cases.

When the sympathetic nerves that innervate the visceral area in which the tumor is located are interrupted, not only the pathways of the painful sensations but also the vasomotor pathways in the same area are removed. Section of the vasomotor innervation is followed by vasodilatation in the area of the tumor, and this increases the nutrition of the neoplastic tissues and multiplication of the tumor cells. In short, there is a double effect when the sympathetic innervation is interrupted: (1) relief of pain by interruption of the pathways of painful sensations and perhaps also by relief of vascular spasm and, (2) vasodilatation from interruption of the vasomotor innervation.

1. Leriche, R.: The Surgery of Pain, translated and edited by A. Young, Baltimore, Williams & Wilkins Company, 1939.

2. Greenhill, J. P.: Control of Pain in Cases of Cancer, M. Clin. North America **25**:117, 1941.

Is it possible to relieve the pain by interruption of the sympathetic pathways and at the same time prevent the adverse influence of the local increase of circulation by postoperative physical therapy?

To study this important problem I have investigated a series of cases of cancer of the cervix uteri. In the Portuguese Institute of Oncology, a group of patients with cancer of the cervix uteri were treated by radium and by daily repeated anesthetic blocks of the lumbar sympathetic chain. The results for these patients were compared with those for a similar series treated with radium therapy alone, i. e., without the interruption of the sympathetic innervation of the uterus. The results of these investigations are the basis of this study. In addition, investigations were made to determine the pathways and the mechanism of painful sensations in carcinoma of the cervix uteri and the vasomotor influence of the sympathetic innervation on the organs in the pelvis and the lower extremities.

PAIN IN CARCINOMA OF CERVIX UTERI; MECHANISM AND PATHWAYS OF THE PAINFUL SENSATIONS

In carcinoma of the cervix uteri, pain is felt when the adjacent structures in the pelvis have been invaded. Pain referred to the lower extremities occurs only when extension of the cancer has involved the adjacent nerves (Cutler and Buschke [3]). It is admitted that the neoplastic invasion of the ligamentous supporting structures of the uterus frequently produces a dull aching pain in the back that may radiate anteriorly to the groin. When constant dull pain occurs in this region, it is thought to be due to the invasion of the broad ligaments (Graves [4]). The occlusion of the ureter by extension of the cancer may also induce pain.

In the following analysis of the mechanism of pain in carcinoma of the cervix uteri, I have excluded the localized and fixed prevertebral pain due to compression of the nerve trunks and also the spinal pain provoked by localized metastases. The treatment by posterior radicotomy or cordotomy is indicated for involvement of the cerebrospinal nervous system. In this study, only the pain of a diffused type produced by the stimulation of the sympathetic innervation of the uterus and adjacent structures will be considered.

In a series of 10 cases of carcinoma of the cervix uteri, I investigated the sympathetic mechanism of pain by blocking the innervation of the organs of the pelvic cavity with procaine hydrochloride. The patients had been treated previously by radium and roentgen rays, and

3. Cutler, M., and Buschke, F.: Cancer: Its Diagnosis and Treatment, Philadelphia, W. B. Saunders Company, 1938.

4. Graves, cited by Cutler and Buschke.[3]

in every case this treatment was followed by healing of the cervix. In all cases, however, continuous and diffuse pain low in the back and in the abdomen radiating to the left groin persisted. These patients were all submitted to repeated anesthetic blocks of the lumbar sympathetic chain at the level of the first, second and third lumbar ganglions unilaterally or bilaterally.

In 6 patients the pain was relieved from one to one and a half hours, after which it returned with the same intensity as before. In 1 patient the repeated anesthetic blocks caused a reduction of the edema of the left lower extremity and relieved the pain low in the abdomen, but a slight pain persisted at the level of the left sacroiliac joint. In 3 other patients, relief of pain lasted twenty days in 1 and fifty days in another; in the third, who had begun to feel slight pain low in the back and low in the abdomen nine years after the radium treatment, the pain was relieved for four and a half months.

How are such different results following the same method of interruption of the sympathetic pathways of the organs of the pelvic cavity to be explained? Possibly in those patients in whom the repeated anesthetic blocks relieved the pain for only one to one and a half hours, i. e., the time corresponding to anesthesia by infiltration, an organic and permanent stimulation of the sympathetic innervation from invasion of the tumor was responsible.

However, the results observed in the last 3 patients suggest that another mechanism may be responsible for the pain in carcinoma of the cervix uteri. The relief of pain for a period exceeding the normal anesthetic action of the procaine hydrochloride suggests the participation of another factor, possibly vascular. It is known that when the sympathetic chains are interrupted beyond the section of the afferent pathways interruption of the efferent pathways also results, and this is followed by vasodilatation, which is maintained longer than the period of anesthesia. On the other hand, it is claimed by some (Leriche[5]; Campbell[6]) that vasoconstriction may cause pain. The neoplastic lymphangitis stimulates the perivascular innervation to produce vasoconstriction and may also induce pain. Hence one can suppose that pain will disappear when the vasoconstriction is relieved by anesthetic block.

In patients with carcinoma of the genital organs, I have endeavored to learn whether stimulation of the lymph nodes and of the lympathic vessels by a chemical drug will cause pain and also whether the afferent pathways pass through the sympathetic system. In 3 patients, 1 to 3 cc.

5. Leriche, R., and Stricker, P.: Recherches expérimentales sur le nerf presacré, Bull. et mém. Soc. nat. de chir. **53**:819, 1927.

6. Campbell, W. G.: Rôle of Sympathetic Nervous System in Segmental Pain, Lancet **2**:930, 1939.

of Uroselectan (sodium 2-oxo-5 iodopyridine-N-acetate), which is opaque to roentgen rays and slightly irritative to the lymph vessels, was injected into a lymph node of the groin. The injection was followed by diffuse pain in each patient. During the injection roentgenograms were taken to find out whether the drug had been taken into the lymph nodes and the lymph vessels only (fig. 1). Then the lumbar sympathetic chain was blocked at the level of the second and third lumbar ganglions and in a few minutes the pain had been completely relieved.

Moreover, in phlebitis and after mechanical stimulation of the innervation of a femoral vein or artery, I have observed the relief of pain

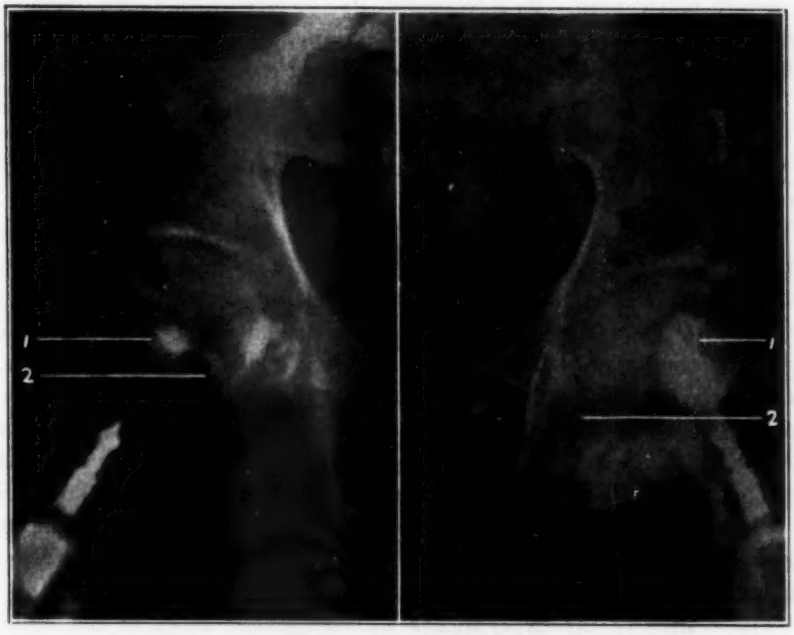

Fig. 1.—Lymphangiogram of the lymph nodes and lymph vessels in patients during the injection of Uroselectan into a lymph node of the groin. The injection was followed by diffused pain that was relieved in a few minutes after the anesthetic block of the lumbar sympathetic chain: *1*, lymph node; *2*, lymph vessel.

by anesthetic block of the lumbar sympathetic chain. These facts suggest that the stimulation of the perivascular innervation of the lymphatic vessels, veins and arteries by inflammatory or neoplastic lymphangitis may also be a cause of pain in carcinoma of the cervix uteri.

PATHWAYS OF PAINFUL SENSATIONS OF THE UTERUS

The afferent pathways that conduct painful sensations of the uterus follow a course that must be known in order to treat the pain resulting

from carcinoma of the cervix uteri. Cotte,[7] in 1925, showed that section of the presacral nerves abolishes the pain of dysmenorrhea produced by contraction of the uterus. Leriche and Stricker [8] (1927) stimulated the intact presacral nerve or the central end of the sectioned nerves in dogs, and the stimulations provoked caused the dogs to awaken from deep general anesthesia; the animals groaned as if suffering from intense pain. Fontaine and Herrmann [8] agreed that the hypogastric plexus carries the important pathways of sensation from the internal genital organs to the medullary centers. They pointed out that interruption of the superior hypogastric plexus is a safe, simple and effective way to treat the functional type of dysmenorrhea and to relieve other forms of severe pelvic pain. In 22 cases of dysmenorrhea or pelvic plexalgia, they came to the conclusion that resection of the presacral nerve was followed by full and lasting relief from pelvic pain in the great majority of the cases.

The investigations of Leriche,[9] employing periarterial sympathectomy of the hypogastric and ovarian arteries, also suggested the role of the innervation of these vessels in pelvic pain.

The problem of the afferent pathways conducting the painful sensations of the uterus was recently investigated by Cleland,[10] who demonstrated that labor pains, due to uterine contractions, are transmitted by afferent fibers that pass through the eleventh and twelfth thoracic roots and concluded that paravertebral block of the eleventh and twelfth thoracic roots will abolish pain from uterine contraction for periods that varied with the type of anesthetic used. The results of Shumacker, Manahan and Hellman [11] (1943) and Jarvis [12] (1944) with anesthetic block of the lumbar sympathetic chain in the treatment of labor pains supply evidence that the afferent pathways that conduct painful sensations of the uterus pass through the lumbar sympathetic chain before reaching the eleventh and twelfth thoracic roots.

The results of my experiments with anesthetic block of the lumbar sympathetic chain in the treatment of pain in cancer of the uterus

7. Cotte, G.: La sympathectomie hypogastrique a-t-elle sa place dans la therapeutique gynécologique? Presse méd. **33**:98, 1925.

8. Fontaine, R., and Herrmann, L. G.: Clinical and Experimental Basis for Surgery of the Pelvic Sympathetic Nerves in Gynecology, Surg., Gynec. & Obst. **54**:133, 1932.

9. Leriche, R.: Résultats de la sympathectomie faite sur les artères hypogastrique et ovarienne en gynécologie, Presse méd. **33**:465, 1925.

10. Cleland, J. G. P.: Paravertebral Anaesthetic in Obstetrics, Surg., Gynec. & Obst. **57**:51, 1933.

11. Shumacker, H. B.; Manahan, C. P., and Hellman, L. M.: Sympathetic Anesthesia in Labor, Am. J. Obst. & Gynec. **45**:129, 1943.

12. Jarvis, S. M.: Paravertebral Sympathetic Nerve Block: A Method for the Safe and Painless Conduct of Labor, Am. J. Obst. & Gynec. **47**:335, 1944.

confirm the results observed in the relief of labor pains. In cases of carcinoma of the cervix uteri, I observed that the anesthetic block with procaine hydrochloride at the level of the first, second and third lumbar ganglions was followed by relief of pain—i. e., the afferent pathways of painful sensations of the uterus were temporarily interrupted at these levels in the lumbar sympathetic chain.

Finally, these results demonstrate that the afferent pathways of painful sensations of the uterus reach the eleventh and twelfth thoracic roots through the hypogastric plexus and the lumbar sympathetic chain (fig. 2).

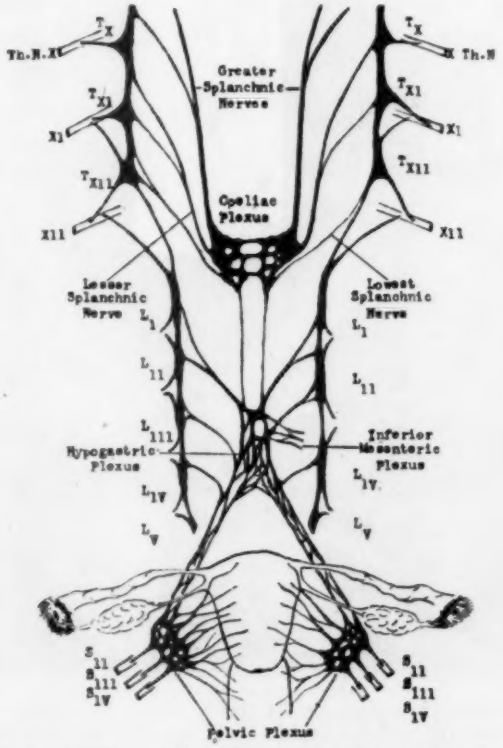

Fig. 2.—Sympathetic innervation of the uterus.

INVESTIGATIONS CONCERNING THE INFLUENCE OF ABDOMINO-PELVIC SYMPATHECTOMY AND ANESTHETIC BLOCK ON THE ARTERIAL CIRCULATION OF THE PELVIS AND LOWER EXTREMITIES

To determine the vasomotor influence of the abdominopelvic sympathectomy on the development of collateral arterial circulation in the pelvis and in the lower extremities, a series of experiments on animals has been performed. In 46 dogs, studies were made on the influence of the various types of abdominopelvic sympathectomies on the development of arterial circulation in the pelvis and in the

lower extremities after ligation of the hypogastric arteries. With the animals under general ether anesthesia, a paramedian and retroumbilical incision permitted one to attain by transperitoneal approach the hypogastric arteries, the presacral nerves, the inferior mesenteric plexus, the periaortic plexus and the lumbar sympathetic chains.

On all the animals, I ligated the hypogastric arteries bilaterally and close to their origin. With the circulation in the pelvis disturbed in this way, I tried by different sympathetic interventions to influence the development of the collateral arterial circulation in the pelvis. To control the results, the sympathetic interruption was always made unilaterally and on the left side. It then became possible to compare under identical technical conditions and in the same animal

Fig. 3 (experiment 1).—Ligation of the hypogastric arteries and resection of the left presacral nerve. Arteriographic study six days and thirteen days after the operation on the dog. Note the greater vascular tree on the left side, resulting from section of the presacral nerve.

the development of the arterial collateral circulation in the sympathectomized and nonsympathectomized sides.

Sodium iodide was used as the roentgenographic contrast medium for arterial injections when the experiments were completed. Injections were made into the abdominal aorta (with sodium iodide) immediately below the origin of the renal arteries under pressure. Arteriography during the injection gave the image, in the living anesthetized animal, of the arterial circulation in the pelvis and in the posterior extremities.

In order to determine the influence of the abdominal sympathectomies on the arterial collateral circulation in the pelvis and in the lower extremities following

ligation of the hypogastric arteries, I made six series of experiments, progressively increasing the number of sympathetic interventions. These with their results are briefly reviewed.

Series 1.—In 19 animals I ligated the hypogastric arteries at the same height, and the left presacral nerve was resected from its origin, close to the posterior mesenteric artery, to its termination in the pelvic plexus. The animals were kept under observation from a few days to several months and then studied during life by the radiographic method (arteriography).

Fig. 4 (experiment 2).—Ligation of the hypogastric arteries and sympathectomy of the left hypogastric artery. Arteriographic study twenty-one days after the operation on the dog.

Six days after this experiment, arteriography already revealed larger arterial collateral circulation on the sympathectomized left side, not only in the uterus and annex but also in the pelvic cavity (fig. 3). Thirteen days later, the development of the arterial collateral circulation was more advanced. The left half of the pelvic cavity presented a more extensive arterial network than did the opposite side (fig. 3). In some

experiments it was observed that resection of the presacral nerve similarly influenced the circulation in the bladder; the arterial network in that half of the organ was richer than in the opposite side. These experiments demonstrated that resection of the presacral nerve induces an increase of the arterial collateral circulation in the corresponding half of the pelvic organs.

Series 2.—In another series (4 experiments), after ligation of the hypogastric arteries, the periarterial plexus of the left hypogastric artery was removed. The animals were kept under observation for varying periods after operation. Usually no large collateral circulation in the pelvis was to be noticed on the sympathectomized side (fig. 4).

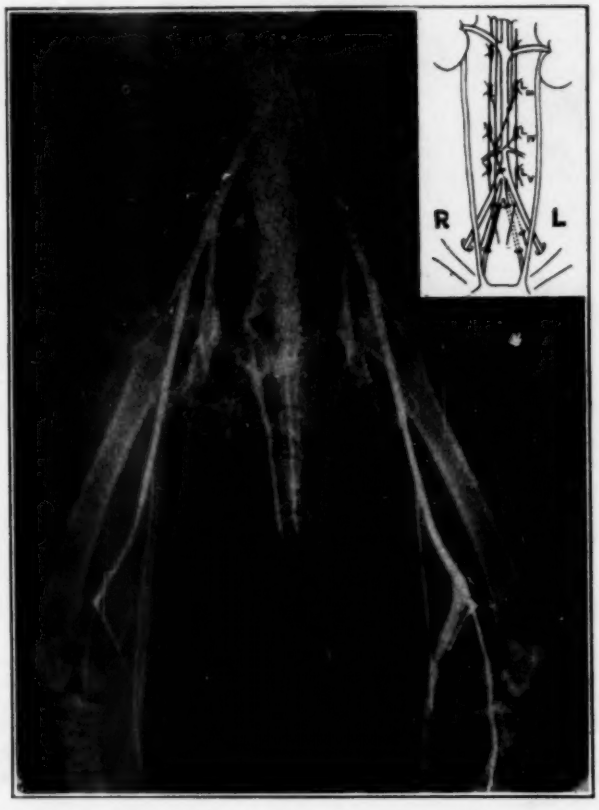

Fig. 5 (experiment 3).—Ligation of the hypogastric arteries followed by resection of the left presacral nerve and section of the left hypogastric artery. Arteriographic study five and a half months after the operation on the dog.

Series 3.—Interruption of the vasomotor sympathetic pathways which follow the presacral nerves and of those which follow the adventitia of the left hypogastric artery determines a status of vasodilatation in the corresponding half of the pelvis; this is shown in the increase of

arterial collateral circulation a few days later (4 dogs). A few months after the intervention, this increase in arterial collateral circulation became greater (2 dogs). Development of arterial collateral circulation was manifest not only in the vessels of the viscera but likewise in the wall of the pelvis in that half of the side corresponding to that of the sympathetic intervention (fig. 5).

Series 4.—In 5 cases in which ligation of the hypogastric arteries had been followed by resection of the left presacral nerve and a lower

Fig. 6 (experiment 4).—Ligation of the hypogastric arteries followed by resection of the left presacral nerve and resection of the left fourth lumbar sympathetic ganglion. Arteriographic study nine days after the operation on the dog.

lumbar sympathectomy of the fourth lumbar ganglion on the same side, an increased arterial collateral circulation was observed in the corresponding side of the pelvis. The vasomotor effect was not limited to the pelvic cavity, but extended to the left leg. At the level of the thigh and the calf, the arterial circulation was greater than in the extremity on the opposite side (fig. 6).

Series 5.—Resection of the left presacral nerve, with the fourth lumbar sympathetic ganglion and the left perihypogastric sympathectomy, caused an increase in the arterial network not only on the left side of the pelvis but also in the leg of the same side (fig. 7). As this was verified for 8 dogs, on examination of the arteriographies of these experiments, I was left with the impression that the increase noted in the arterial collateral circulation following intervention was more pronounced than had been observed in the previous set of experiments.

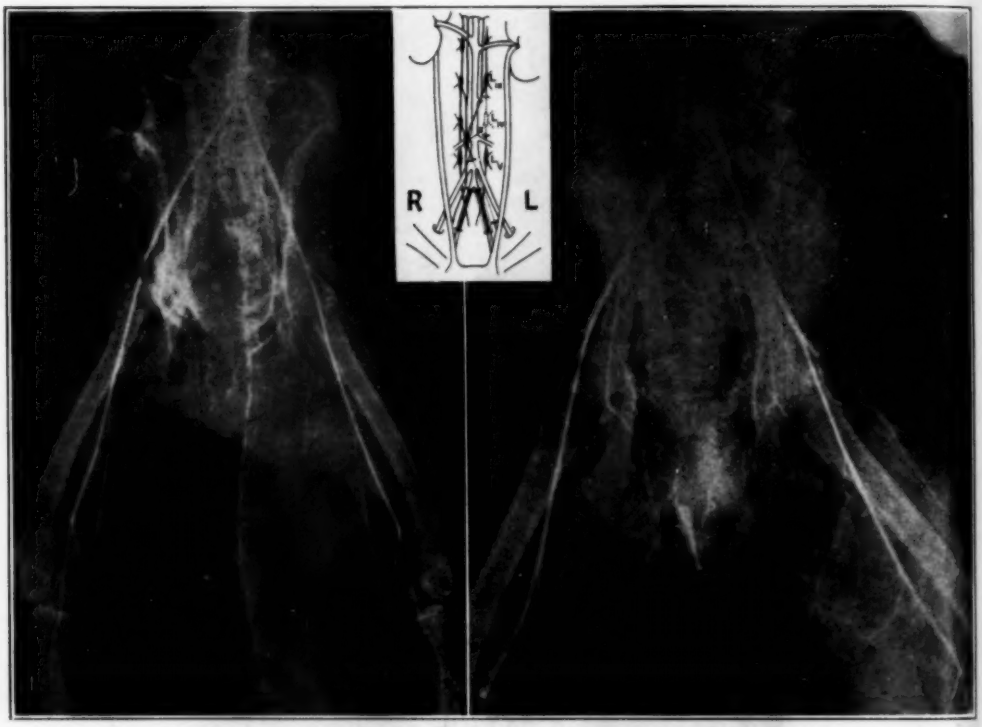

Fig. 7 (experiment 5).—Ligation of both hypogastric arteries followed by resection of the left presacral nerve, resection of the left fourth lumbar sympathetic ganglion and sympathectomy of the left hypogastric artery. Arteriographic studies fourteen and twenty days after the operation.

Series 6.—Finally, in the last series of experiments (4 dogs), in addition to the resection of the left presacral nerve, resection of the fourth and fifth lumbar ganglions and periaortic sympathectomy were added. There followed a vasomotor effect in these 4 cases which showed in the following days and months an evident increase in arterial collateral circulation at the level of the pelvis and the posterior extremity on the side sympathectomized. It was in these cases that the development of arterial collateral circulation in the pelvis and the posterior extremity

attained the maximum intensity as compared with the previous experiments (fig. 8).

INFLUENCE OF ANESTHETIC BLOCK OF THE LUMBAR SYMPATHETIC CHAIN ON CIRCULATION OF THE GENITAL ORGANS AND OF THE LOWER EXTREMITIES

The results already mentioned obtained in the experimental investigations performed on animals led me to investigate the circulatory change produced by interruption of the lumbar sympathetic chain in patients with cancer of the cervix uteri. Not only the arterial change in the uterus but also the circulation of the lower extremity on the

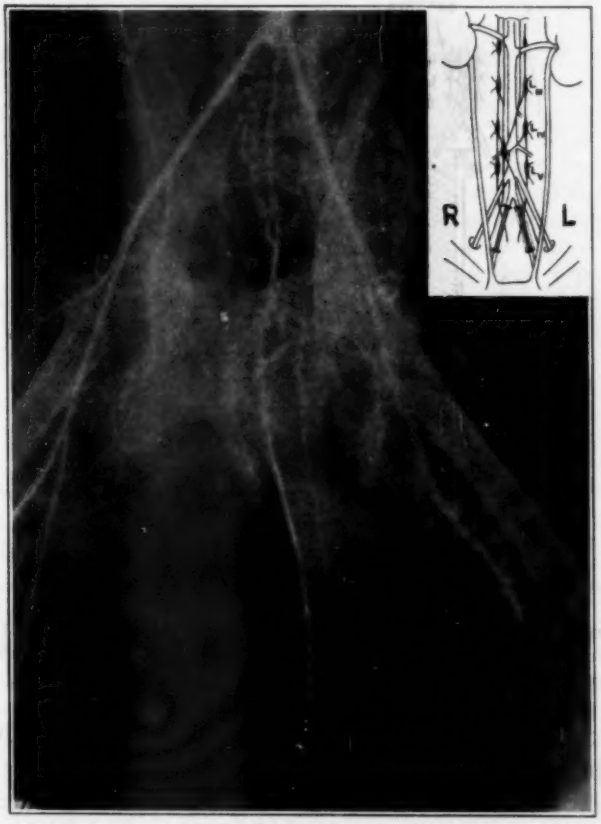

Fig. 8 (experiment 6).—Ligation of the hypogastric arteries followed by resection of the left presacral nerve, resection of the left fourth and fifth lumbar sympathetic ganglions and periaortic sympathectomy. Arteriogram four months later.

same side was studied. These changes in the local blood supply were investigated indirectly through the modification of the local temperature taken at the same time in the uterus, in the fornices of the vagina

and in the lower extremities. This was done with different electrodes of an electric thermometer. Local temperatures were observed before and after the anesthetic block of the lumbar sympathetic chain. For about one hour the temperatures, taken every five minutes, were recorded at the level of the regions where the electrodes were placed.

Several observations were made after anesthetic block of the lumbar sympathetic chain was performed at different levels, in some cases at the level of the first lumbar ganglion, in some at the second, in others at the third and finally at the fourth lumbar ganglion. These observations showed that in all the cases interruption of the lumbar sympathetic chain was followed by an increase in the temperature of the uterus,

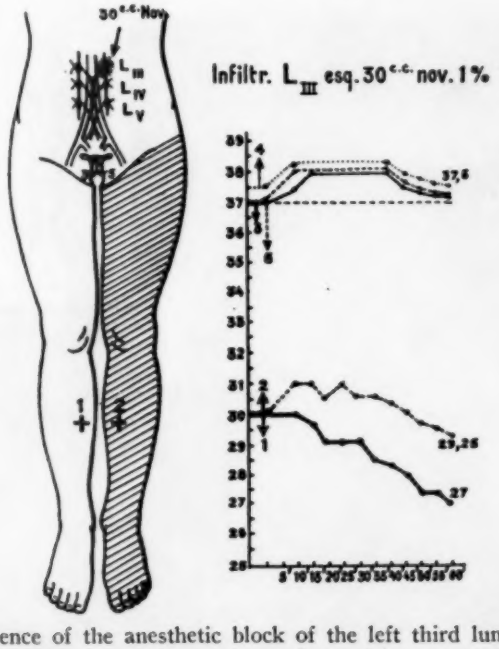

Fig. 9.—Influence of the anesthetic block of the left third lumbar sympathetic ganglion on the temperature of the uterus, vagina and lower extremity, in a patient with carcinoma of the cervix uteri.

of the fornices of the vagina and of the lower extremity on the side of the sympathetic intervention. The 2 cases that follow give an idea of the modification of local temperature produced by unilateral anesthetic block, with procaine hydrochloride, of the second or third lumbar sympathetic ganglions.

Case 1.—A patient with a basal cell carcinoma of the cervix uteri in stage II was given an injection of 30 cc. of 1 per cent solution of procaine hydrochloride into the second lumbar ganglion on the left side. Ten minutes after the beginning of anesthesia, the temperature in the uterus had risen from 37 C. (98.6 F.) to 37.9 C. (100.2 F.) and in the left fornix to 37.8 C. (100 F.); in both it rose to 38 C.

(100.4 F.) after fifteen minutes. In the right fornix, the temperature rose from 37 C. (98.6 F.) to 37.5 C. (99.5 F.) in ten minutes. The temperature of the left leg rose from 30 C. (86 F.) to 31.25 C. (88.2 F.) in ten minutes; in the lower extremity on the opposite side there was no noticeable increase in temperature.

CASE 2.—A patient with a basal cell carcinoma of the cervix uteri in stage I was given an injection into the left third lumbar sympathetic ganglion. The temperature at the level of the orifice of the cervix uteri rose from 37.5 C. (99.5 F.) to 38 C. (100.4 F.) and at the level of the left fornix of the vagina from 37 C. (98.6 F.) to 38 C. (100.4 F.) (fig. 9). In the right fornix of the vagina it rose only to 37.3 C. (99.1 F.). At the end of fifteen minutes the temperature was 38.2 C. (100.7 F.) in the cervix uteri and 38 C. (100.4 F.) in the fornices of the vagina, remaining steady for forty minutes, after which it began to decline. An hour later it was 37.6 C. (99.6 F.) in the cervix and 37.5 C. (99.5 F.) in both fornices. In the lower extremity on the side of the anesthetic block the temperature rose in ten minutes from 30 C. (86 F.) to 31 C. (87.8 F.). It remained there for twenty-five minutes but began to decline, and at thirty minutes it was 30.5 C. (86.9 F.).

Examination of all thermal variations verified in this case after anesthetic blocking of the left lumbar sympathetic chain by infiltration of procaine hydrochloride in the left third lumbar ganglion showed that there had followed an immediate rise in temperature at the level of the cervix uteri and in the left fornix of the vagina. The temperature of the right fornix rose to the same height but five minutes later. This hyperthermia of the uterus and the vaginal fornices continued the same for forty minutes and then began to decline. One hour later it was still higher than it had been before the anesthetic block. In the left lower extremity the temperature increased 1 degree (C.) in twenty-five minutes, after which it started to drop progressively.

VASOMOTOR INFLUENCE OF THE SYMPATHETIC ABDOMINOPELVIC INNERVATION ON THE BLOOD SUPPLY OF THE UTERUS

The abundance of nerve fibers in the uterine musculature and along the blood vessels has been shown clearly by the more recent investigations of the intrinsic innervation of the uterus (Kuntz [13]). In regard to the vasomotor innervation of the uterus and fallopian tubes, Kuntz stated that the sympathetic supply includes the vasoconstrictor fibers for the female genitalia. The vasodilator fibers appear to be components of the parasympathetic nerves. It is now known that interruption of the vasoconstrictor fibers supplying an organ is followed by dilatation of the blood vessels in that organ, probably by removing the impulses that maintain the tonus of the smooth muscle of the vessels. The resultant vasodilatation also increases the development of collateral circulation, a phenomenon manifest when the main vascular trunks are interrupted.

The aforementioned experiments performed on dogs showed that the unilateral resection of the hypogastric plexus was followed by an

13. Kuntz, A.: The Autonomic Nervous System, Philadelphia, Lea & Febiger, 1934.

increase of arterial collateral circulation at the level of the same side of the uterus and the wall of the pelvic cavity. Less evident was the effect produced by sympathectomy of the left hypogastric artery. On the other hand, interruption of the vasomotor pathways of the innervation of the genital organs at the level of the lumbar sympathetic chain plus periaortic sympathectomy produced the maximum increased collateral arterial circulation.

In patients with carcinoma of the cervix uteri, these experimental results are confirmed. Anesthetic block of the lumbar sympathetic chain at the level of the first, the second or the third ganglion provoked an increase in local temperature at the level of the endocervical canal of the uterus and of the fornix of the vagina on the same side as the interruption of the vasomotor sympathetic innervation.

All these facts show that the uterus is innervated by efferent sympathetic vasomotor fibers and that interruption of these sympathetic pathways is followed by vasodilatation, which provokes an increased temperature at the level of the uterus and an increased collateral circulation.

PROBLEM OF RADIOSENSITIVITY AND BLOOD SUPPLY IN CANCER

In the interpretation of the results of radium therapy for cancer of the cervix, one must take into consideration not only the technic of the irradiation but also such factors as the extent of the lesions, the cervicouterine microbial infection, the age of the patient, the histologic type of the cancer and its radiosensitivity.

In the statistics of Simone Laborde,[14] the decrease in the number of cures is shown as the extension of the lesion increases. Thus if the percentage of cured patients in stage I is 66 per cent, it decreases to 48 per cent in stage II and drops to 30 per cent in stage III. The cervicouterine microbial infection not only decreases the local radiosensitivity of the infected neoplasia but can even originate accidents in the course of radium therapy (Simone Laborde). Age is also a factor; it is known that in young women the malignity and rapidity of evolution of carcinomas of the cervix are more pronounced than in women of advanced age. The morphologic varieties and the histologic types of carcinomas of the cervix behave differently in their relation to irradiation. Simone Laborde[15] says that the vegetating cancers are less malignant and are more quickly modified under the influence of the

14. Laborde, S.: Les résultats de la radiothérapie des cancers cervico-utérins du premier degré: Statistique de l'Institut du cancer, Bull. Assoc. franç. p. l'étude du cancer **30**:43, 1942.

15. Laborde, S.: Que se pode esperar de radioterapia dos cancros, Arq. de pat. **11**:26, 1939.

radiation than are the infiltrating or ulcerous forms. Cutler [16] has stated the strong conviction that the gross character of the lesion, more particularly of its papillary or infiltrating character, may be, in certain circumstances, a more significant guide to radiosensitivity than is the microscopic appearance of the growth. And Cathie [17] concluded from his investigations that some of the tumors showing atypical histologic features manifested a typical radiosensitivity, while, on the other hand, in his series of some 5,500 cases there were many atypical responses by histologically similar tumors. From these facts, it is obvious that it will not be possible to give a certain forecast of sensitivity of the tumor from the histologic preparations. According to Cathie,[17] however, one should indicate as nearly as possible the probabilities of radiosensitivity when reporting on biopsy material.

Though it is indeed difficult to estimate the degree of radiosensitivity of various carcinomas of the cervix, a number of attempts have been made to determine the existing relation between the histologic types and the sensitivity of the tumor to irradiation. Some authors have already established for carcinomas of the cervix different degrees of radiosensitivity in relation to cellular differentiation. The carcinomas with cellular elements of adult type appear to be the most radioresistant; those offering greater sensitivity to radiation are the carcinomas of undifferentiated cells (basal cell and transitional cell). Yet the evaluation of radiosensitivity through the histologic type presents a certain difficulty of practical application in the case of carcinomas of the cervix, since it is not easy to define the histologic types on account of the rarity of pure forms and the variety of morphologic aspects according to the location of the biopsy. This means, therefore, that one cannot submit to any schematic formula the radiosensitivity of the neoplasms of the cervix. The radiosensitivity of a tumor plays an almost dominant role in the radiotherapy of cancer (Stewart and Farrow [18]). The selection of the treatment to be followed depends on the sensitivity of a tumor to irradiation; in some instances this is curative, in others simply palliative. However, until the present time there has been no method of determining beforehand with precision whether or not a tumor is sensitive to radiation. Therapeutic practice led Stewart and Farrow [18] to the conclusion that the behavior of tumors to radiation is an individual problem.

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16. Cutler, M.: The Problem of Radiosensitivity, J. A. M. A. **103**:1204 (Oct. 20) 1934.

17. Cathie, J. A. B.: Some Histological Tumor Variants and Their Influence upon Radiosensitivity, Radiology **32**:425, 1939.

18. Stewart, F. W., and Farrow, J. H.: The Radiosensitivity of Tumors, in Pack, G. T., and Livingston, E. M.: Treatment of Cancer and Allied Diseases, New York, Paul B. Hoeber, Inc., 1940, vol. 1, p. 98.

In regard to the radiosensitivity of the tumor cells themselves, Cutler and Buschke [3] declared that one can distinguish three forms of radiosensitivity: inherent, transient and acquired. Very early Regaud [19] had already demonstrated that the same cell is more radiosensitive during certain active phases of mitosis than during a phase of repose. This observation led to the conclusion that the cellular radiosensitivity decreases as the cell advances in its evolution toward maturity or higher differentiation. According to Cutler and Buschke,[3] however, the generally admitted opinion that the degree of cellular differentiation is inversely proportional to the radiosensitivity is not an invariable rule.

As to the acquired radiosensitivity, though it is not known how to account for the increase of inherent radiosensitivity, it is known that it can be decreased by certain external factors. Thus a previous irradiation or an inadequate surgical intervention or yet a disturbance of the normal blood supply of the tissues can interfere with the radiosensitivity of a tumor. Cutler and Buschke [3] stated that clinical and experimental observations indicate that its radiosensitivity is decreased when the blood supply of a tissue is reduced. This reasoning has suggested an effort to attain a normal blood irrigation in the treatment of cancer by irradiation. Investigations have already been made to increase the blood supply and the oxygenation of a tumor, before or during irradiation, by diathermy and the injection of oxidizing substances into the tumor.

It is now known that the radioresistance of a tumor may increase when the irradiation is distributed over a long period or is applied repeatedly. Such a fact would probably result from alterations in the neoplastic cells and from the modification (fibrosis and decrease of vascularization) that takes place in vascularity of the connective tissue in and about the tumor. Cutler and Buschke, therefore, stated the belief that the radiosensitivity of a tumor is determined as much by the environment of the tumor as by its histologic structure. According to Warren,[20] the regression of an irradiated tumor is dependent on changes in the supporting stroma and both the blood vessels and the connective tissue as well as on the destruction of tumor cells. Lenz and Haagensen [21] stated the belief that the resistance of the tissues to irradiation is greatly influenced by their nutrition and vascularization. They pointed out that the vasodilatation following the application of heat or of irritating medicaments increases the radiosensitivity of the skin; on the contrary, it decreases the radiosensitivity if the nutrition or the local blood supply is poor.

19. Regaud, cited by Cutler and Buschke.[3]

20. Warren, S.: The Radiosensitivity of Tumors, Am. J. Roentgenol. **45**:641, 1941.

21. Lenz, M., and Haagensen, C. D.: The Treatment of Cancer, in Nelson's Loose-Leaf Living Surgery, New York, Thos. Nelson & Sons, 1927, vol. 2, p. 135.

In the irradiation of tumors one can still observe the phenomenon of radioimmunization, which, according to Simone Laborde,[15] represents one of the difficulties in the radiotherapy of cancers. Thus a malignant tumor, after it has reacted favorably to the first irradiation, can become immune to subsequent irradiations and is not influenced by them. Simone Leborde [15] and Roussy and Leroux [22] attributed, in part, the phenomenon of radiovaccination to the state of the vasculoconnective stroma modified by previous irradiations. Cutler and Buschke [3] stated that an acquired radioresistance may be due in part to inadequate previous radiologic or surgical treatment or to any interference with the normal blood supply of the tissues. They cite as an example a carcinoma developing in an operative scar or burn—i. e., in a devascularized skin—its radiosensitivity being much less than that observed in a carcinoma implanted in the normal skin.

On the other hand, the changes determined by the irradiation of carcinomas of the cervix have been studied during the course of treatment by repeated biopsies. It has been shown that during the period of from twenty-four to thirty-six hours after the beginning of irradiation there is usually a decrease in the number of mitoses (Lenz and Haagensen [21]); this is followed by a phase of increase in the number of mitoses, which are largely atypical. This phase of active degeneration shows a greater or a less duration according to the type of the tumor and the intensity of the radiation. Ewing and Pullinger [23] have pointed out that the irradiation is effective largely through the vascular disturbance that it creates.

It is now known that the irradiation of a tumor is followed by immediate and slow alterations in the supporting vasculoconnective tissue by sclerosis. This fibrosclerosis, appearing before the destruction of the malignant cells, can reduce the blood supply of the region to the extent of making sterilization impossible (Cutler and Bushke [3]). The decrease in the vascularity of the connective tissue after irradiation is due to sclerosis of the internal and muscular layers and, subsequently, obliteration of the vessels. This leads to atrophy and at the same time creates favorable conditions for infection. The idea of reducing sclerosis from irradiation has already been put into practice. In carcinomas of the cervix submitted to irradiation, Gentil [24] and Guedes [25] tried the complementary treatment by gynecologic diathermy. This therapeutic

22. Roussy and Leroux, cited by Laborde.[15]

23. Ewing and Pullinger, cited by Lenz and Haagensen.[21]

24. Gentil, F.: La diathermie gynécologique, moyen auxiliaire precieux de la curietherapie utero-vaginale, Arq. de pat. **2**:300, 1930.

25. Guedes, B.: La diathermie gynecologique, moyen auxiliaire de la curiethérapie utérovaginale, Cong. internat. de physiol., 1930.

innovation is at the present time followed at the Portuguese Institute of Oncology, and the results obtained have encouraged its continuation.

From an analysis of the facts now known about the radiosensitivity of tumors, radioimmunization, the mechanism of the cellular action of irradiation and the changes in the vasculoconnective stroma of cancer, it would appear that the vascular factor plays an important role in the results from irradiation.

Quick,[26] in 1942, analyzing the present state of radium therapy, discussed the treatment of carcinoma of the cervix and corpus uteri. He suggested that further investigation is necessary to discover a method of preirradiation therapy that will render the tumor-bearing area more sensitive to irradiation. Quick pointed out that in the search for ways and means of rendering tumor tissues more sensitive to irradiation and normal tissues more resistant one must not lose sight of the biophysiologic factor. He stated that it has long been known that an optimum response to a given amount of radiation does not occur in the presence of secondary anemia. Daland[27] agreed that when the circulation of the region is poor the harmful effect of irradiation is greater. The circulation after radium therapy becomes poorer in the area treated, and closure of vessels to that region will result in gangrene of the area.

According to Cutler[16] there is considerable evidence to indicate that tumors pass through alternating periods of radioresistance and radiosensitivity. The radiosensitivity of a cell is not constant. When the metabolic rate is high, as in rapidly growing tumors, radiosensitivity is high (Mottram[28]). That changes in metabolism affect response to irradiation seems to be demonstrated by the experiments of Packard[29]; he showed that lowering the metabolic rate by reducing the temperature lowered the susceptibility to irradiation.

On animals Jolly[30] performed ligation of the common iliac artery of one side. Then, for one or two hours he irradiated simultaneously the popliteal lymph nodes of the two lower extremities. By histologic study he verified in two, three or four hours after the end of the irradia-

26. Quick, D.: The Present States of Radium Therapy, Am. J. Roentgenol. **47**:607, 1942; Radium in Present Day Therapeusis, New York State J. Med. **44**: 981, 1944.

27. Daland, E. M.: Radiation Damage to Tissue and Its Repair, Surg., Gynec. & Obst. **72**:372, 1941.

28. Mottram, J. C.: On the Spacing of Radiation According to Variation in Radio-Sensitivity, Brit. J. Radiol. **9**:824, 1936.

29. Packard, cited by Cutler.[16]

30. Jolly, J.: Action des rayons x sur les cellules: Diminution de la réaction d'un organe sensible par la ligature des artères afférentes, Compt. rend. Soc. de biol. **91**:532, 1924.

tion that the alterations were less pronounced in the lymph nodes with diminished arterial blood supply. This would probably be explained by the qualitative and quantitative modification of cellular exchanges. A similar effect was demonstrated by Ferroux, Jolly and Lacassagne [31] by ligating one ovarian pedicle and irradiating both ovaries simultaneously. They reported that the effects of irradiation were minimal in the ovary with the lesser blood supply. These experiments demonstrate that the intervention of the supply of blood to the organs exposed to irradiation is followed by increased radioresistance.

In my investigations concerning the influence of the sympathetic innervation in the treatment of pain in inoperable cancers, I was led to study the role of the increased blood supply of the tumor resulting from intervention of the vasomotor innervation in relation to increased radiosensitivity. According to Cutler,[16] the ultimate criterion and only absolute test of the radiosensitivity of the tumor is its clinical behavior. And since the response of a tumor to irradiation, the therapeutic test, remains the most accurate and certain clue to its radiosensitivity, I have investigated in patients the influence of hyperemia produced by sympathetic block in radium therapy of carcinoma of the cervix uteri.

TECHNIC USED IN INTERRUPTION OF INNERVATION OF THE UTERUS BY REPEATED ANESTHETIC BLOCKS OF THE LUMBAR SYMPATHETIC CHAIN

The uterus derives its nerve supply mainly from the anterior border of the large portion of the pelvic plexus (Hovelacque [32]). These nervous filaments constitute the uterine plexus, which is connected with the vaginal plexus. In woman, the pelvic plexus, which is similar to that in man, arises in the bifurcation of the hypogastric plexus. Both the right and the left pelvic plexuses descend into the pelvic cavity, following a divergent course, to round the posterior and lateral surfaces of the rectum afterward; then they continue forward without, however, attaining the lateral border of the uterus. The hypogastric plexus represents the continuation of the intermesenteric plexus, which receives its principal roots from the lumbar sympathetic chains.

It is at the level of the lumbar sympathetic chain and its efferent branches and roots of the intermesenteric and of the hypogastric plexuses, that one can intercept either the afferent (sensory) or the efferent (vasomotor) pathways, which, following the hypogastric plexus and the hypogastric arteries, innervate the uterus. Anesthesia of the lumbar sympathetic chain and of the roots of the hypogastric plexus interrupts

31. Ferroux, Jolly and Lacassagne, cited by Cutler and Buschke.[3]

32. Hovelacque, A.: Anatomie des nerfs craniens et rachidiens et du système grand sympathique, chez l'homme, Paris, G. Doin & Cie, 1927.

the pathways of painful sensations, arising in the uterus and running along the hypogastric plexuses to reach the lumbar sympathetic chain and the spinal cord, through the eleventh and twelfth thoracic nerves. This effect is shown during the treatment with intrauterine radium by a decrease of local painful sensibility. From such observations I had the impression that the patients tolerated radium better and complained less than during the period of treatment when repeated anesthetic blocks of the lumbar sympathetic chain were performed.

In the series of investigations, the results of which this work presents, I made anesthetic blocks on the right and on the left every day during the period of radium application. With 30 cc. of 1 per cent procaine hydrochloride solution, the lumbar sympathetic chain at the level of the first, second or third lumbar vertebra was infiltrated in each patient, and, in order that the punctures might be better tolerated, they were always made at different points.

The technic of anesthetic block of the lumbar sympathetic chain is easy and has been described by several authors (Lundy,[33] Leriche,[34] Ochsner and De Bakey [35]). In these investigations I have employed a similar technic but with modifications that experience advised. The patient is placed in a sitting or a lateral recumbent position with the dorsum bent forward. Then the outlines of the spinous processes of the last rib, the transverse processes of the lumbar vertebrae and the iliac crests are marked. From these landmarks, which determine the site of the lumbar sympathetic ganglions, the level of the desired block can be determined.

Then at a point lying from 2.5 to 5 cm. from the sagittal plane of the spinal processes, one introduces a needle of 10 to 12 cm. in length. When the needle is introduced 2.5 cm. from the middle line, it must be passed parallel to the sagittal plane between the two transverse processes, so that on reaching the body of the vertebra it will follow the border of the latter. If, however, the needle is introduced laterally at a distance greater than 2.5 cm., it should be inclined toward the sagittal plane, to permit its just grazing the lateral border of the body of the vertebra. As soon as the point of the needle touches the body of the vertebra or a transverse process, it is withdrawn a little and inclined more obliquely so that it will continue in its deeper progression to graze the lateral border of the body of the vertebra. It is pressed 1 or 2 cm. farther, and then one has the feeling of having penetrated

33. Lundy, J. S.: Clinical Anesthesia: A Manual of Clinical Anesthesiology, Philadelphia, W. B. Saunders Company, 1944, p. 159.

34. Leriche, R., and Fontaine, R.: Technic and Indications for Procaine Hydrochloride Infiltration of Lumbar Sympathetic, Presse méd. **42**:1843, 1934.

35. Ochsner, A., and De Bakey, M.: Treatment of Thrombophlebitis by Novocaine Block of Sympathetics: Technique of Injection, Surgery **5**:491, 1939.

into a free space, with less resistance. The point of the needle is then in front of the anterior surface of the psoas muscle, which covers the sympathetic chain. Aspiration is made in order to be sure that there is no bleeding; then slowly 30 cc. of 1 per cent procaine hydrochloride solution without epinephrine is injected. In this way it is possible to obtain the physiologic interruption of the sympathetic chain at the level at which the anesthetic infiltration is made.

This procedure is repeated at the level of the first, second or third lumbar sympathetic ganglion, depending on the desired anesthetic block. The anesthetic, diffusing in front of the psoas muscle close to the vertebral body, anesthetizes not only the sympathetic chain but also the roots of the hypogastric plexus. The resulting physiologic block not only reduces the painful sensibility of the uterus but also increases its blood supply. Probably a similar result may be obtained by blocking the lumbar sympathetic chain with alcohol or long-acting anesthetic drugs.

RESULTS OBTAINED IN TREATMENT OF CARCINOMA OF THE CERVIX UTERI BY RADIUM THERAPY ALONE OR BY RADIUM THERAPY ASSOCIATED WITH HYPEREMIA; IMMEDIATE RESULTS

For one year I studied all patients with carcinoma of the cervix uteri who were treated at the Portuguese Institute of Oncology. About half of them were submitted to routine treatment by radium therapy, preceded and followed by roentgen ray therapy, with gynecologic diathermy added. In other patients, during the period of application of radium, a state of hyperemia at the level of the uterus was induced by repeated daily lumbar blocks with procaine hydrochloride. There was no special selection of patients in either series; the treatment was maintained for six months in all cases. The results, therefore, are from different stages (I, II and III), from patients of different ages and from tumors of diverse morphologic types.

The cases are grouped as (1) basal cell carcinomas and (2) adenocarcinomas of the cervix. In interpreting the results for each of these groups, the stage of the neoplasia, the patient's age, the dose of radium and the technic of irradiation were considered. The results are restricted to a period of a year and a half after the treatment.

The technic of irradiation used for these patients was the one routinely used at the Portuguese Institute of Oncology: roentgen rays, in doses of 2,400 r, preceding the use of radium in the uterus and vagina in the habitual dose of 50 mg., and roentgen rays in doses of 16,600 r following the use of radium and gynecologic diathermy.

Repeated gynecologic examinations were made of these patients in order to evaluate the evolution of the lesions. The examinations were continued at variable intervals during the months that followed.

I. Series of Patients Routinely Treated Without Sympathetic Block.—1. The first group of patients with basal cell carcinomas comprises 34. Six patients with carcinoma of the cervix in stage I were of ages varying from 23 to 56 years. The doses of radium applied to the uterus and vagina varied from 25 to 50 mg. The results in these 6 patients were as follows: The cervix healed in 4 patients at the end of the treatment and remained well for periods up to fourteen months; 1 was worse at the end of the treatment, and the other had a recurrence of the lesion six months later.

2. In 8 patients between the ages of 37 and 63, the carcinoma of the cervix was of stage I or II; the doses of radium varied between 25 and 50 mg. In 4 cases the cervix was healed, and nothing was heard afterward of recurrence. In 3 of the others the neoplasia recurred, and in 1 case the lesion did not improve.

3. In 18 patients with basal cell carcinoma of the cervix in stage II, the ages ranged from 29 to 68. The doses of radium applied were from 25 to 50 mg. In only 8 of these patients was there healing without recurrence within the period of observation. In 4 patients the lesions grew worse, and 1 of these died in four months. Of the remaining 5, frank recurrence was shown in 2 and clinical signs that made recurrence probable in 3.

4. Finally, 2 patients, aged 59 and 66 years, had basal cell carcinoma of the cervix uteri in stage III. In 1 case the dose was 27 mg. and in the other 25 mg. The former showed an unimproved lesion at the end of the treatment; the second died.

II. Series of Patients Given Routine Treatment Plus Sympathetic Blocks.—In the second series of patients with basal cell carcinoma of the cervix uteri (28), I made repeated daily anesthetic blocks of the uterine innervation during the period of application of radium with procaine hydrochloride infiltration of the lumbar sympathetic chain on both sides. In this way it proved possible not only to reduce the uterine pain but also to create a state of hyperemia at the level of the organs of the pelvic cavity. The following results were obtained in this series of patients with basal cell carcinoma:

1. In 11 patients with carcinoma of the cervix uteri in stage I, the ages were from 31 to 61 years and the doses of radium employed ranged between 27 and 50 mg. Of these 11 patients, the cervix healed in 10 and remained well during the period of observation. In only 1 patient did the lesion recur, four months later.

2. In 1 patient, aged 52 years, the carcinoma of the cervix was in stage I-II. Radium was applied to the vagina and uterus in a dose of 50 mg. The cervix healed, but the tumor recurred locally four months later.

3. In the 12 patients with carcinoma of the cervix uteri in stage II, the ages ranged from 35 to 59 years. The doses of radium applied varied between 27 and 60 mg. In 6 the cervix healed and was in good condition after the treatment; in 3 the cancer recurred three to four months after the treatment, and in 2 the lesion grew worse. In 1 the lesion of the cervix healed, but there were metastases to the bones.

4. In 1 patient, aged 68, with carcinoma of the cervix uteri in stage III, to whom a dose of radium of 50 mg. was applied to the uterus and vagina the lesion healed, but it recurred two months later.

5. In 3 patients with carcinoma of the cervix and body of the uterus, whose ages ranged between 49 and 54 years, doses of radium of 27 to 50 mg. were applied. The first of these patients died one month

TABLE 1.—*Results in Treatment of Carcinoma of the Cervix Uteri*

Stage	Cases	Improvement	No Improvement	Recurrence	Death	Metastasis to Bone
Treatment with Radium Alone (34 Cases)						
I	6	4	1	1	..	..
I-II	8	4	1	3	..	..
II	18	8	4	5	1	..
III	2	..	1	..	1	..
Treatment with Radium and Repeated Anesthetic Blocks of the Lumbar Sympathetic Chain (28 Cases)						
I	11	10	..	1	..	..
I-II	1	..	..	1	..	..
II	12	6	2	3	..	1
III	1	..	..	1	..	..
Carcinoma of cervix and body of uterus	3	2	..	..	1	..

after treatment; in the 2 others the cervix healed and kept well eight and twelve months respectively after the treatment.

I have also attempted to analyze the results of the treatment in relation to the neoplastic stage in this series of observations of basal cell carcinoma of the cervix uteri. Table 1 illustrates the results obtained in these cases (1) with radium only and (2) with lumbar sympathetic blocks.

An analysis of the results obtained in the series of 34 patients with basal cell carcinomas of the cervix uteri treated by radium and following the orientation routinely adopted in the Portuguese Institute of Oncology is given in table 2. During a period of observation lasting for one and a half years, the results were as follows: improved 47 per cent; unimproved 20 per cent; recurrence 26 per cent and died 5 per cent.

Of the 28 patients given radium treatment associated with hyperemia provoked by daily anesthetic blocks of the lumbar sympathetic chain, induced by procaine hydrochloride, 60 per cent improved, 7 per cent

were unimproved, 25 per cent had recurrence, 3 per cent had metastasis to the bone and 3 per cent died during the period of observation.

Besides the 62 patients with basal cell carcinomas of the cervix uteri, there were 5 patients with adenocarcinomas of the cervix uteri. Four of these patients were submitted to the routine treatment by radium, preceded and followed by roentgen ray therapy and completed with gynecologic diathermy. In only 1 of these patients were the lumbar injections of procaine hydrochloride added. These patients were between 40 and 65 years old, and the disease was in stage II. The doses of radium applied were of 50 mg., except in 1 case with an application of 30 mg. The first patient of this series died sixteen months after the treatment, without improvement in the ulceration. The cancer recurred in the second; the third patient was worse after the treatment and died five months later; the result of the fourth case is not known; the fifth patient, aged 53, with an adenocarcinoma of the cervix

TABLE 2.—*Results in Treatment of Carcinoma of the Cervix Uteri*

Treatment with	Improvement, %	No Improvement, %	Recurrence, %	Metastasis to Bone, %	Death, %
Radium, roentgen rays before and after use of radium and gynecologic diathermy (34 cases)	47	20	26	..	5
Radium, roentgen rays before and after use of radium, gynecologic diathermy and repeated anesthetic blocks of the lumbar sympathetic chain (28 cases)	60	7	25	3	3

uteri in stage I-II, was treated by daily lumbar sympathetic blocks; vaginal and uterine radium was applied in a dose of 50 mg. The cervix healed and was well during the period of observation lasting four months.

Analysis of all the results within the short time of one and a half years after treatment showed that in basal cell carcinomas as well as in adenocarcinoma of the cervix uteri, the percentage of cases to show healing of the cervix was higher in the series in which daily repeated anesthetic blocking of the lumbar sympathetic chain were added to the routine radium therapy.

SUMMARY AND CONCLUSIONS

1. The investigations of others suggested that the radiosensitivity of a cancer may be favorably influenced by increasing the blood supply in the tumor during the period of irradiation. This led to this investigation in carcinoma of the cervix uteri to determine whether the interruption of the sympathetic innervation by anesthetic block or by sympathectomy would, in addition to reducing the pain, also increase

the blood supply to that region and be useful in the irradiation of the growth. Both experimental and clinical data are presented.

2. The interruption of the extrinsic sympathetic innervation of the uterus at the level of the lumbar sympathetic chain (first, second and third lumbar ganglions) and of the roots of the hypogastric plexus, besides reducing uterine pain through the physiologic block of the afferent painful pathways, also caused hyperemia of the uterus by blocking the efferent vasomotor sympathetic pathways of this organ.

3. In different types of abdominopelvic sympathectomies in dogs, such as resection of the presacral nerve, lumbar sympathectomy and periaortic sympathectomy, an increased arterial circulation in the organs of the pelvic cavity resulted. The higher the abdominopelvic sympathectomy the greater was this increase in collateral circulation. In the cases of lumbar sympathectomy, an increase of arterial circulation was also observed in the lower extremity on the same side.

4. In the treatment of basal cell carcinomas and adenocarcinomas of the cervix uteri, the application of radium associated with hyperemia of the uterus obtained by repeated lumbar anesthetic blocks induced by procaine hydrochloride, in the first, second and third lumbar ganglions showed that the immediate results, in observation up to a year and a half, presented a greater percentage of healings (60 per cent) of the cancerous lesions in the cervix uteri than in cases in which radium alone was applied (47 per cent). The total series includes 62 cases.

5. The results in this small number of cases do not permit definitive conclusions, but they suggest that the effects of radium are greater when the circulation to the uterus is increased by a block of the lumbar sympathetic chain. This procedure is also helpful in that the uterine pain is relieved.

University of Portugal.

CUTIS GRAFT IN SURGERY

A Review of Results Obtained, with Comments on Indications and Technic and Report of Cases

JOHN E. CANNADAY, M.D.
CHARLESTON, W. VA.

MY COLLEAGUES and I have continued to explore, from time to time, the possibilities of the cutis graft from a theoretic as well as from a practical standpoint. Certainly the field of its usefulness is wide. We have kept in mind the substance of the observations made by various surgeons concerning the special merits of cutis as repair material, such as its pronounced tensile strength and freedom from the tendency to split, the lack of which has been an unfortunate characteristic of fascia lata when subjected to lateral strain.[1] Cutis vascularizes quickly, takes easily and well and is gradually transformed into fibrous tissue. We have made use of cutis tissue whenever and wherever we would have used fascia lata in the past and, we feel, with superior results.[2]

An extended review of our cases has been made through the medium of patients returning for check-up and by correspondence with the patient's physician and with the patient. The results obtained have been generally gratifying and the failures few, the latter, for the most part, apparently having been due to defects in technic.

TECHNIC

Before the application of cutis grafts, our patients have had, on the day previous to operation, preparation with soap and water followed

1. Cannaday, J. E.: The Use of Cutis Graft in Repair of Certain Types of Incisional Herniae and Other Conditions, Ann. Surg. **115**:775-781 (May) 1942; Some of the Uses of Cutis Graft in Surgery, Am. J. Surg. **59**:409-419 (Feb.) 1943; Additional Report on Some of the Uses of Cutis Graft Material in Reparative Surgery, ibid. **67**:382-390 (Feb.) 1945. Ogilvie, W. H., in Maingot, R.: Post-Graduate Surgery, New York, D. Appleton-Century Company, Inc., 1937, vol. 3.

2. Rehn, E.: Das kutane und subkutane Bindegewebe als plastisches Material, München. med. Wchnschr. **61**:118-120, 1914. Rehn, E., and Miyauchi: Das cutane und subcutane Bindegewebe in veränderter Funktion: Eine experimentelle und klinische Transplantationsstudie, Arch. f. klin. Chir. **105**:1-46, 1914. Rehn, E.: Ueber die funktionelle Anpassung des Bindegewebes im chirurgischen Geschehen, Verhandl. d. anat. Gesellsch. **40**:133-152, 1931; in Lexer, E.: Die freien Trans-

by alcohol and a sterile dressing. Shortly before operation an iodine-alcohol technic is carried out.

Our present technic of cutting a cutis graft is as follows: After a thin epidermal layer has been shaved away and the area needed outlined with a scalpel, the cutis edge is picked up at one end with two or three Allis forceps and is removed by undercutting with a short, curved pair of scissors. Approximately not more than 1 mm. thickness of fatty tissue is allowed to remain on the under surface of the graft.

When a strip of cutis is secured for suspension of the cervix, thick cutis, such as can be obtained from the anteroexternal surface of the thigh, has definite advantages. For this purpose, the strip should be cut sufficiently wide (about 1 or 1¼ inches [2.5 or 3 cm.]), as cutis narrows greatly when put on longitudinal stretch.

In the repair of inguinal hernia we have for the most part followed the technic of Halsted. In case the structures are poor and a cutis graft reenforcement seems to be indicated, the graft is usually sutured in position under the aponeurosis of the external oblique muscle.

When cutis is used as suture material, our experience indicates that it can be handled with a medium-curved hemostat as satisfactorily as or more so than with any fascia needle that we have seen.

When the aponeuroses are sutured to the placement of the graft, sutures of adequate strength should be used, usually of cotton thread, sizes 15 to 30; however, stainless steel wire or silk is satisfactory. When the graft is fixed on firm tension, no. 30 sutures, spaced not more than ¼ inch (0.6 cm.) apart, are used. All sutures are interrupted; all knots are tied triple throw style. When cutis is used for reenforcement purposes, the subcutaneous fat should always be carefully sutured down to and over the cutis graft so as to obliterate dead space in the incision. No. 70 or 80 cotton thread is suitable for this.

When the operative incision is closed, the skin edges can be best brought together with vertical mattress sutures. After closure of the wound, a pressure dressing of mechanic's waste is applied. This is usually left in place for ten days or longer.

By use of the removed epidermal layer as a split thickness graft to cover areas from which a cutis graft has been removed, the end results in the donor area are more satisfactory from the cosmetic viewpoint than in the cases in which the skin edges are brought together by undercutting and the use of tension sutures.

Pronounced sudden increase in abdominal constriction resulting from a radical operation for the cure of a large hernia in middle-aged

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plantationen in von Bruns, P.: Neue deutsche Chirurgie, Stuttgart, Ferdinand Enke, 1924, vol. 26b. Peer, L. A., and Paddock, R.: Histologic Studies on the Fate of Deeply Implanted Dermal Grafts, Arch. Surg. **34**:268-290 (Feb.) 1937.

or elderly patients is not without danger.[3] Such patients can be accustomed to increased intra-abdominal tension by the comparatively simple expedient of partial suspension of the abdominal portion of the patient's trunk in a sling for several days prior to operation.

SURGICAL APPLICATIONS

Stage Operations.—In cases of strangulated hernia, the patient's condition may be such that a stage operation is necessary. For instance, the strangulation may be released and the operative incision closed, sufficient time being allowed for the general condition of the patient to improve before repair of the hernia is undertaken.

Suspension of Uterine Cervix by Cutis Strip.—In some cases suspension of the cervix may be made by carrying a strip of cutis through a tunnel made through the periosteal attachments of the rectus muscles. At other times this tunnel is made underneath the periosteum of the tuberculum pubis. However, there are still other cases in which it may seem more feasible to make the tunnel a little more lateral and to carry it under Cooper's ligament and a portion of Gimbernat's ligament near their attachment in the anterior pubic region.

We had formerly, at times, suspended the cervix from the posterior aponeurosis of the rectus muscles near their point of attachment to the pubic arch. However, we have had 2 cases of recurrence of prolapse following this type of procedure. We have had the opportunity of reoperating on both patients. The apparent reason for these recurrences of cervical prolapse was that the anchoring strip of cutis had gradually pulled away from its insertion in the sheath of the posterior rectus muscle.

Ligation of Large Blood Vessels.—Morton and Scott[4] observed that any ligation in continuity of a large artery will be frequently followed by a gradual cutting through of the ligature. Elkin,[5] Gage[6] and others have found fascia to be unsatisfactory for the ligation of large arteries. They stated that bands of fascia frequently give way and that cotton tape at times cuts through. However, Beck[7] reported the apparently successful use of fascia to reenforce the walls of an aneurysm.

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3. Babcock, W. W.: Principles and Practice of Surgery, Philadelphia, Lea & Febiger, 1944, p. 85. Thorek, M.: Modern Surgical Technic, Philadelphia, J. B. Lippincott Company, 1938, vol. 3, p. 1707.

4. Morton, J. J., and Scott, W. J. M.: Ligation of the Abdominal Aorta for Aneurysm Complicated by Rupture into Retroperitoneal Space, Ann. Surg. **119:** 457-467 (March) 1944.

5. Elkin, D. C.: Aneurysm of the Abdominal Aorta: Treatment by Ligation, Ann. Surg. **112:**895-906 (July) 1940.

6. Gage, M.: Personal communication to the author.

Since it has been noted by a number of surgeons that when fascia has been used for the purpose of ligating the aorta it has failed to hold and that cotton tape and rubber bands have at times cut through the wall of that vessel, causing fatal hemorrhage, it seems obvious that a more suitable material is indicated. In view of our satisfactory experience with cutis as material for stage ligation of the common carotid artery, it would seem that cutis may prove to be the material of choice in such cases. The aorta could be reenforced with a wide band of cutis; after this a ligature strip of cutis could be passed twice around the reenforcing layer, drawn tightly enough to cut off the flow of blood wholly or in part and then firmly anchored with interrupted U sutures.

A Suggestion in Regard to Chronic Recurring Dislocation of the Shoulder.—It has been observed that after the Nicola operation of transplanting the long head of the biceps muscle for the relief of chronic, recurrent dislocation of the shoulder this structure practically disappears from the joint within the course of a few months. In view of this fact, it is believed that cutis graft support for the arm would be more likely to offer permanent relief. It is also felt that if cutis were used in accordance with the Henderson type of operation, which does not invade the joint to an appreciable extent, the prospects for a permanent cure would be good.

REPORT OF CASES

CASE 1.—J. F., a white man aged 59, was admitted to the Charleston General Hospital Aug. 17, 1942. Examination showed a direct inguinal hernia, twice recurrent after previous operative repair. The patient underwent a third repair operation on August 19. A direct sac, of moderate size, was found. The structures about the opening were definitely of poor quality. After a repair had been made in accordance with the McVay technic, the area was reenforced with a cutis graft. A recurrence of this hernia developed about two years later.

CASE 2.—Mrs. D. G., a white woman aged 50, was admitted to the Charleston General Hospital Feb. 16, 1945. Her height was 5 feet (152 cm.) and her weight 255 pounds (115.6 Kg.). This patient was certain that she had had a right upper abdominal incisional hernia recurrent for the third time following a cholecystectomy. The exact location of this hernia was not apparent, but the patient was keenly aware of its presence. She even thought that she might have another hernia lower in the abdomen.

Operation.—Operation was performed on February 22 by Dr. R. E. Pence and me. We felt that it would be necessary to reopen the abdomen in order definitely to locate the hernia or hernias of which she complained. Accordingly, an incision was made in the line of a previous right upper abdominal incision. Through this opening, the examining fingers were passed. Only one small hernial opening, about 1¾ inches (6.9 cm.) medial to the exploratory incision, was found.

7. Beck, C. S.: Operation for Aneurysm of the Heart, Ann. Surg. **120**:34-40 (July) 1944.

The sac contained an adherent knuckle of small bowel, which explained the occasional cramping sensation experienced by the patient. After a seemingly adequate repair of the hernia had been made and the peritoneal and aponeurotic structures of the exploratory opening had been closed, the two exposed areas were firmly reenforced with a cutis transplant of appropriate size, the remaining layers of the incision being closed in the usual manner. The patient had a normal convalescence. However, when the pressure dressing was removed, on the tenth postoperative day, two small, reddened patches of skin in the operative area were noted. The impression at this time was that of an apparent circumscribed local cellulitis. Penicillin was administered intramuscularly for a few days, after which the inflammatory areas rapidly disappeared.

Case 3.—R. E. T., a white man aged 44, was admitted to the Charleston General Hospital March 6, 1945. His height was 6 feet 1½ inches (186 cm.)

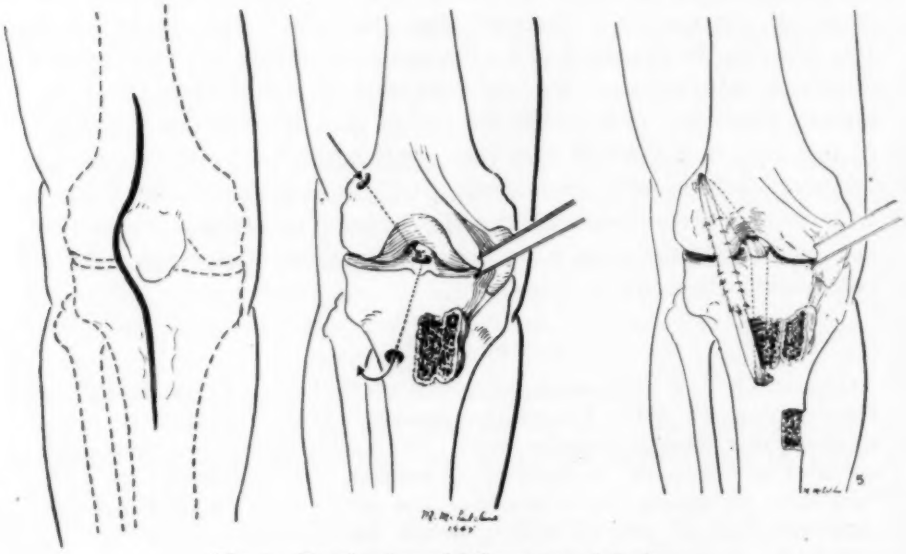

Fig. 1.—Repair of crucial ligaments of the knee.

and his weight 240 pounds (108.8 Kg.). He gave a history of a thrice recurrent incisional hernia in the right side of the upper part of the abdomen following a cholecystectomy. Each of the three subsequent operations for repair had been followed by recurrence of the hernia, which bulged to a pronounced degree and extended practically from the costal border to the inguinal ring. The patient stated that whenever he was on his feet the hernial area was the seat of an almost continuous dull, aching pain.

Operation.—The patient was operated on March 6 by Dr. R. E. Pence and me. When the hernial sac was exposed, it was noted that in the central area the defect in the aponeurosis was approximately 3½ inches (8.8 cm.) in width and also that the bulge extended down to and apparently was continuous with what was evidently an early direct right inguinal hernia. The sac was closed by infolding, multiple interrupted sutures of no. 40 cotton thread being used for this purpose. The aponeurotic structures were approximated with sutures of no. 15 cotton thread tied with triple throw knots. No attempt was made to deal

with the inguinal hernia because of the fact that the operation would have been unnecessarily prolonged and also by reason of the fact that the inguinal part of the hernia so far had not caused pain. The hernial repair was firmly reenforced with a cutis graft (which, when cut and sutured in place on tension, was at least 8½ inches [21.5 cm.] long by 2½ inches [6 cm.] wide) taken from the antero-external surface of the right thigh. The interrupted anchoring sutures of no. 40 cotton thread were spaced about ¼ inch apart and tied twice firmly in the usual double throw knot. The patient, being under continuous spinal anesthesia, gave a slight cough at this stage of the operation. Simultaneously, it seemed, at least twelve of the fixation sutures slipped untied, as if by magic. All the graft fixation sutures were then replaced by no. 30 cotton thread tied with triple throw knots instead of double.

This patient was allowed to get out of bed each day subsequent to the operation. A few days following the operation the patient had a slight accession of fever. Roentgenologic examination showed evidence of a moderate amount of bronchitis. This cleared up in a few days.

The pressure dressing was removed on the tenth postoperative day to allow for the removal of the vertical mattress skin sutures. Following this, there was a small amount of serous leakage from the lower angle of the wound. This drainage persisted for about six months, gradually diminishing in amount, after which time the operative incision was apparently entirely healed.

Before the superficial sinus finally closed, it was noted that a small area (about ¼ inch) of the tip of one corner of the cutis graft was visible. However, it was firmly fixed in the tissues and was apparently well covered with epidermis.

Follow-up.—Recent examination with the patient standing shows the repaired area to be firm and without any sign of a bulge. The patient stated that there is complete freedom from the pain he formerly experienced. He also said that he recently spent a two weeks vacation on his father's farm and while there helped with the farm work without experiencing any discomfort whatever from the physical effort.

CASE 4.—Mrs. M. O., a white woman aged 60, was admitted to the Charleston General Hospital April 13, 1944. She stated that she underwent two operations on the lower part of the abdomen between twenty and thirty years ago, at one time having her appendix removed and at another having a ventrofixation of the uterus. Physical examination showed two incision scars in the lower part of the abdomen. In the area between these, there was a moderate herniation. Pelvic examination showed a cystocele, grade 3 to 4, and prolapse of the uterus, grade 1. The perineum was in fair condition. A moderate senile vaginitis was apparent.

On April 14 conization of the cervix and repair of the cystocele were done. The cystocele was repaired with use of local (procaine hydrochloride) anesthesia. On April 18 the patient underwent subtotal hysterectomy and suspension of the cervical stump by means of a strip of cutis taken from the edge of the abdominal incision. With this strip of cutis the cervix was anchored to the under surface of the lower rectus aponeurosis at about its point of attachment to the pubic arch. Incidental to the closure of the abdominal incision, the old incisional hernia was repaired, a cutis graft patch being used for reenforcement. The patient had a moderate degree of fever for about one week following the suspension operation, after which her temperature dropped to normal and remained so up to the time she left the hospital.

On March 3, 1945 this patient was readmitted to the hospital, complaining of recurrence of the uterine prolapse, which, she stated, took place about six months after her last operation. Vaginal examination showed the presence of a definite recurrence of the prolapse. The results of the vaginal operation were good. Likewise, the incisional hernia had not recurred.

On March 8 this patient's abdomen was reopened along the line of the previous lower abdominal incision. The cutis graft used as reenforcement in the repair of the incisional hernia was intact and in place. The cervix had completely broken

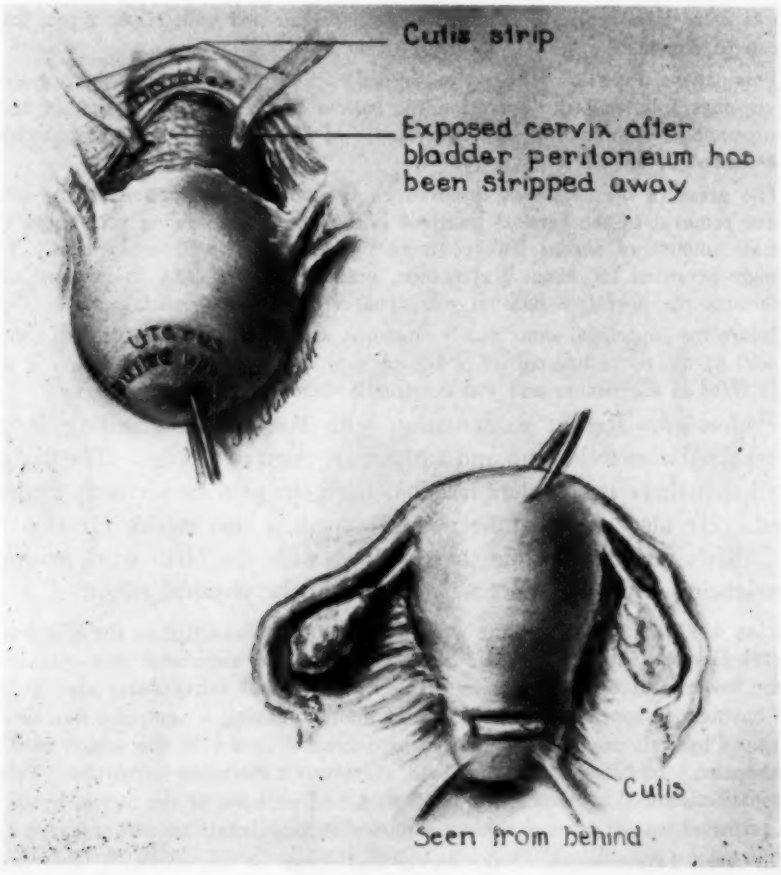

Fig. 2 (case 4).—Cutis graft treatment of the cervix of the uterus.

away from its moorings. The previously implanted cutis strip had apparently pulled entirely free from its base above the pubis and was lying, for the most part, over the right broad ligament, to which it was adherent. This strip of cutis was completely peritonized.

The upper portion of the cervical stump was mobilized and firmly drawn up back of the pubis. The fold of bladder peritoneum adjacent to the pubis had been previously incised and pushed downward from the posterior surface of the pubis for a short distance. A heavy strip of cutis, ⅞ inch (2.2 cm.) wide and of suitable

length, was taken from the anteroexternal surface of the right thigh. The ends of this cutis strip were carried under the periosteum of the tuberculum pubis at about the insertion of Poupart's and Cooper's ligaments. This cutis strip was carried partly through and partly under Gimbernat's and Cooper's ligaments at a point lateral to the tuberculum pubis. A similar maneuver was carried out on the opposite side of the pubic arch. The free ends of the cutis suture were then

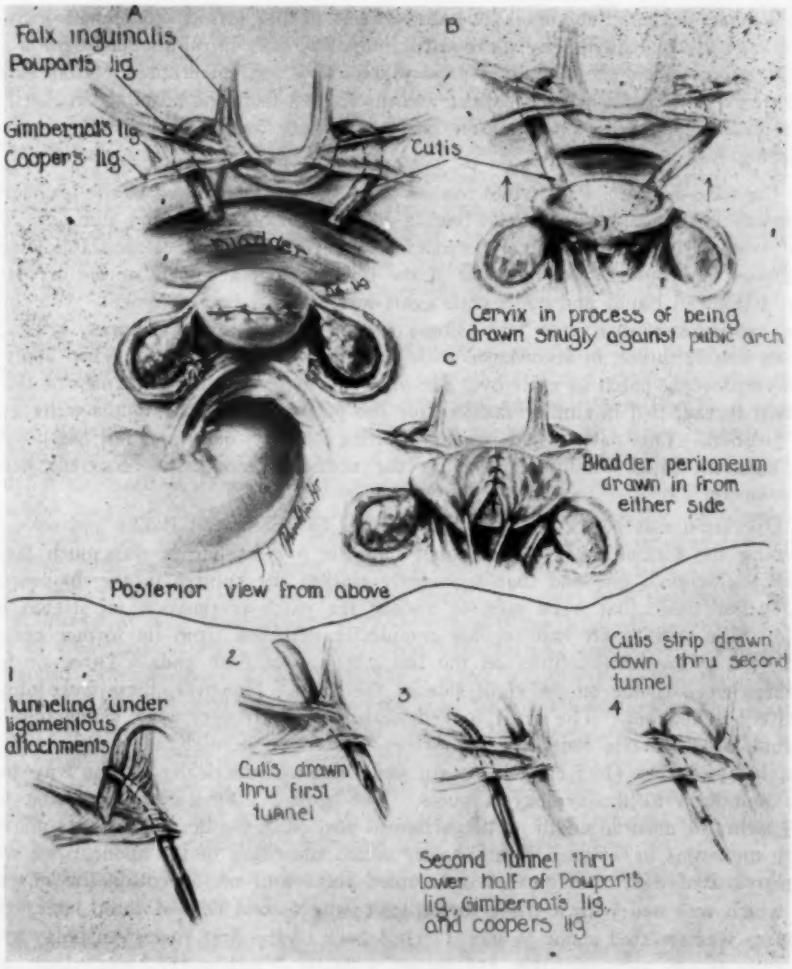

Fig. 3 (case 4).—Details of procedure.

carried through the cervical stump, which was drawn up in place behind the pubic arch, after which both free ends of the cutis ligature were anchored together with interrupted sutures of no. 15 cotton thread. The edges of the peritoneum of the bladder were sutured over the point of suspension so as to render the cutis ligature and its immediate attachments extraperitoneal. The abdominal incision was closed in the usual manner.

The patient's temperature ran a normal course during the first five postoperative days, after which it rose to 100 F. for two successive days. About this time the presence of a small, reddened area of skin in the region of the lower end of the incision was noted. This was thought to indicate a local area of dermatitis or cellulitis. The patient was given penicillin intramuscularly for three or four days. The redness of the skin disappeared; likewise, the temperature dropped to normal and remained so. The patient was discharged March 18, 1945.

On April 6, 1945 the patient returned to the hospital, complaining of a small, superficial, draining abscess at the lower end of the former abdominal incision. She was given penicillin by local instillations and also intramuscularly for a few days, after which the abscess was explored and one interrupted cotton thread suture recovered. When the patient was discharged from the hospital, on April 20, she was in apparent good condition, her temperature was normal and the drainage opening was nearly healed.

CASE 5.—Mrs. R. P., a white woman aged 49, was readmitted to the Charleston General Hospital April 4, 1945, having had a previous admission Feb. 26, 1944, for repair of a large, ventral postoperative hernia which developed following a previous laparotomy. At the time of the first attempt at repair of the hernia by Dr. Bankhead Banks and me, a cutis graft was used for reenforcement. We closed the aponeurotic structures with single no. 30 cotton thread sutures, tying the knots double throw, in accordance with our practice at that time. When applying the reenforcing patch of cutis over the area, we used interrupted sutures of no. 40 cotton thread, tied in similar fashion, for the purpose of anchoring the cutis graft in position. This patient had primary healing of the wound and left the hospital in apparent good condition. During the next six months a recurrent hernia developed.

Operation was performed April 7, 1945 by Dr. Bankhead Banks and me. On opening the former incision, we noted that the present hernia was much larger than the original one and that apparently neither the sutures in the aponeurotic edges nor those that were used to anchor the patch in position on stretch had held. The cutis graft had become completely detached from its former contact with the aponeurotic sutures on the left side and at both ends. Three or four sutures were visible on the right side of the graft. However, these were almost entirely pulled out. The graft looked healthy and in every way viable but had shrunk to about one fourth of its former size. The hernial bulge was approximately 6½ inches (16.5 cm.) in length and extended practically all the way from the umbilicus to the symphysis pubis. The spread in the central portion was 2½ inches or more in width. The peritoneal portion of the hernial sac was plicated with numerous interrupted sutures, after which the edges of the aponeuroses were approximated with two rows of interrupted sutures of no. 15 cotton thread, each of which was tied with a triple throw knot; the second row of these interrupted sutures was inserted about ⅜ inch (1 cm.) back of the first row. An onlay graft of cutis tissue, approximately 1¾ inches wide by 7 inches (17.7 cm.) long, was sutured in place under firm tension with triple throw tied interrupted sutures of no. 30 cotton thread, after which the lower portion of the subcutaneous fatty layer adjacent to the incision was sutured firmly down to the center of the graft. The skin was closed with vertical mattress sutures. A moderate pressure dressing was applied.

This patient had a normal convalescence and was discharged from the hospital about two weeks following operation. To date there is no sign of recurrence of the hernia.

CASE 6.—Miss D. W., a white woman aged 19, was admitted to the Charleston General Hospital, Oct. 12, 1944, with a history of recent severe injury of the left knee resulting from an automobile accident. Roentgenologic examination showed pronounced lateral and moderate posterior dislocation of the distal end of the femur in relation to the tibia. There were several chip fractures along the medial condyle of the distal end of the femur. There was obviously a gross dislocation of the left knee joint, resulting in a flail joint. An irregular laceration of the skin over the knee was present. The relation of the femoral condyles and the head of the tibia was exceedingly unstable, so much so that it was with considerable difficulty that sufficient fixation of these structures could be maintained while a plaster cast was being applied to the leg and thigh. Roentgenologic examination indicated that the relative position of the head of the tibia and the femoral condyles was not very good. After a few days the cast was removed. Further adjustments were made, and a long leg cast was snugly applied. Later this cast was wedged so as to correct a medial angulation at the knee.

Operation.—An operation was performed on Nov. 30, 1944 by Dr. George Tsunekawa and me for the reconstruction of the crucial ligaments of the knee. This operation was based in part on a technic described by Albee,[8] in which fascia lata had been used for the replacement of ruptured crucial ligaments of the knee.

Apparently both anterior and posterior crucial ligaments had been ruptured. (From the extreme instability noted at the time of admission, it was believed that all the major ligaments of the knee had been put out of commission.) A parapatellar incision was made on the lateral side of the knee. The tibial tubercle was chiseled free from the anterior surface of the tibia. When the patella was retracted mesially, an excellent exposure of the interior of the knee joint was given. A ⅜ inch hole was drilled through the side of the condyle and into the intercondylar space. Likewise, a similar drill opening was made through the head of the tibia, extending back to about the center of the articular head of the tibia. A strip of cutis 7 inches long by 1½ inches wide was used. This was held taut while being keyed into position by bone wedges both above and below. In addition to this, the ends of this strip of cutis were overlapped and fastened together with multiple interrupted sutures of no. 30 cotton thread. While it had been extremely difficult to hold the knee in anything like correct position for application of the plaster cast at the time of operation, as a result of local healing processes, the knee was to a considerable extent fixed in a relatively normal position.

On Oct. 22, 1944, the patient was discharged from the hospital, wearing a leg-thigh cast, which she wore for about eight weeks, after removal of which she wore a knee brace for several weeks and went about on crutches.

Recent reports from this patient indicate that she has had a satisfactory result and is able to use her leg in a normal manner.

CASE 7.—S. F., a white man aged 45, was admitted to the Charleston General Hospital, Oct. 17, 1944, with a history of severe trauma to the calf of his right leg, after which a painful bulge developed on the back of the injured leg below the knee.[9] This swelling was particularly apparent when the patient put his weight on the leg in question. He stated that when the leg was at rest the swelling dis-

8. Albee, F.: A New Operation for the Repair of the Crucial Ligaments of the Knee, Am. J. Surg. **60**:349-353 (June) 1943.

9. Simon, H. E., and Sacchet, H. A.: Muscle Hernias of the Leg, Am. J. Surg. **67**:87-97 (Jan.) 1945.

appeared. On palpation around the edges of the involved area, the aponeurotic margins could be felt. The hernial bulge was about 2¼ by 2¾ inches (6 by 6.9 cm.).

Operation.—At operation on Oct. 18, 1944, after the skin and subcutaneous fat were dissected away from the hernial area, it was noted that the aponeurotic structures over the gastrocnemius muscle were definitely ruptured along a central line on the posterior surface of the leg. The edges of the ruptured aponeuroses were brought together with interrupted sutures of no. 30 cotton thread, after which a cutis graft, which had been taken from the anteroexternal aspect of the thigh of the same side, was sutured into position on tension. The subcutaneous fat was sutured over the graft, after which the skin was closed with vertical mattress sutures. A pressure dressing of mechanic's waste was applied. This was kept in place for ten days.

A check-up on this patient Nov. 30, 1944 and a letter from his physician disclosed the fact that the region of the former hernia was free from pain and that the operative result had been satisfactory.

This patient was again admitted to the hospital Aug. 15, 1945, complaining of repeated attacks of cramping of the muscles of the right leg and also extreme discomfort in the area of the cutis graft repair, as a result of having been thrown violently to the ground while operating mining equipment.

At operation August 17, the previously placed cutis graft was found to be in excellent condition and apparently firmly attached at the edges. There was laxity in the graft, perhaps a little more than would be normally found in the aponeurosis over the gastrocnemius muscle. The skin graft was so firm and thick that it was found to be well nigh impossible to pass a surgical gut needle through it, and accordingly cervix needles were used in plicating the old graft.

An incision was made along the line of the previous scar over the calf of the right leg. The newly created aponeurosis was tightened up by plication with several interrupted cotton sutures. It was not thought advisable to place an additional cutis graft, as the one previously sutured into position was tough and resistant to tension.

The following cases are reported from the neurosurgical service of Dr. A. A. Wilson.

CASE 8.—Mrs. F. M., a white woman aged 70, was admitted to the Charleston General Hospital, Sept. 9, 1943, with a history of having had evidence of a spontaneous subarachnoid hemorrhage some three weeks before admission. She made a fairly prompt recovery from the effects of the hemorrhage, although she continued to complain of diplopia and intense pain back of the right eye. A few days before admission symptoms developed indicating a paralysis of the third nerve on the right side. She was in this condition when admitted.

There were no other neurologic abnormalities. There was change neither in the field nor in the disk. It was felt with reasonable certainty that this patient had an intracranial aneurysm of the right internal carotid artery. Stage ligation of the common carotid artery was believed to be indicated.

Operation.—The patient was operated on Sept. 15, 1943 by Dr. A. A. Wilson and me. The common carotid artery was exposed and clamped and the patient taken to the x-ray room, where 10 cc. of colloidal thorium dioxide (Thorotrast) was injected into the artery distal to the clamp, and roentgenograms were taken. This procedure clearly indicated the presence of an aneurysm. The patient was returned to the operating room, where a strip of cutis was wrapped thrice around

the artery and drawn tightly enough almost, but not entirely, to stop the flow of blood coming through. The ends of the cutis strip were firmly anchored with cotton sutures. The wound was closed with fine silk. The patient was immediately relieved of pain back of the right eye.

Operation (Second Stage).—On September 23, the operative wound was reopened and an attempt made to separate the encircling strip of cutis from the

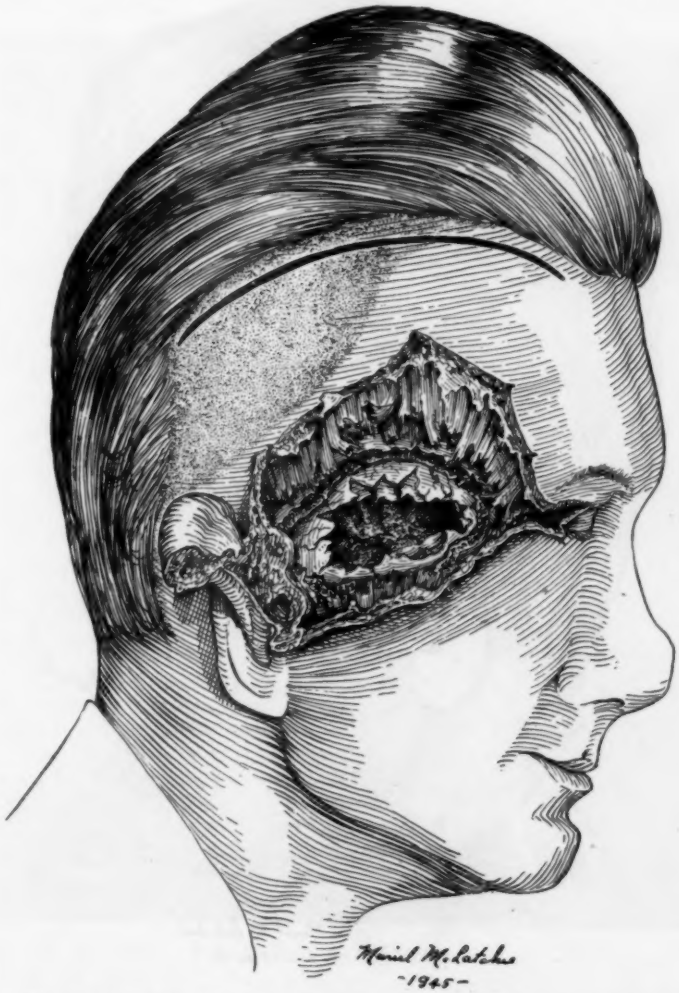

Fig. 4 (case 9).—Cutis graft operation in right temporal area.

artery. However, it was so completely fused with the walls of the vessel that the attempt had to be given up. In an endeavor to separate the strip of cutis from the artery, a tear was made in the artery. There was a free escape of blood, which was promptly controlled by the application of a clamp followed by a cotton ligature. The arterial trunk was then exposed a little farther down, after which it was ligated with umbilical tape.

Dr. Wilson stated that this patient has continued to remain free from pain and, according to recent reports from her family physician and from her son, has apparently remained in good condition.

CASE 9.—E. A., a 15 year old boy, was admitted to the Charleston General Hospital, Oct. 28, 1944. He had received a shotgun charge (bird shot) at close

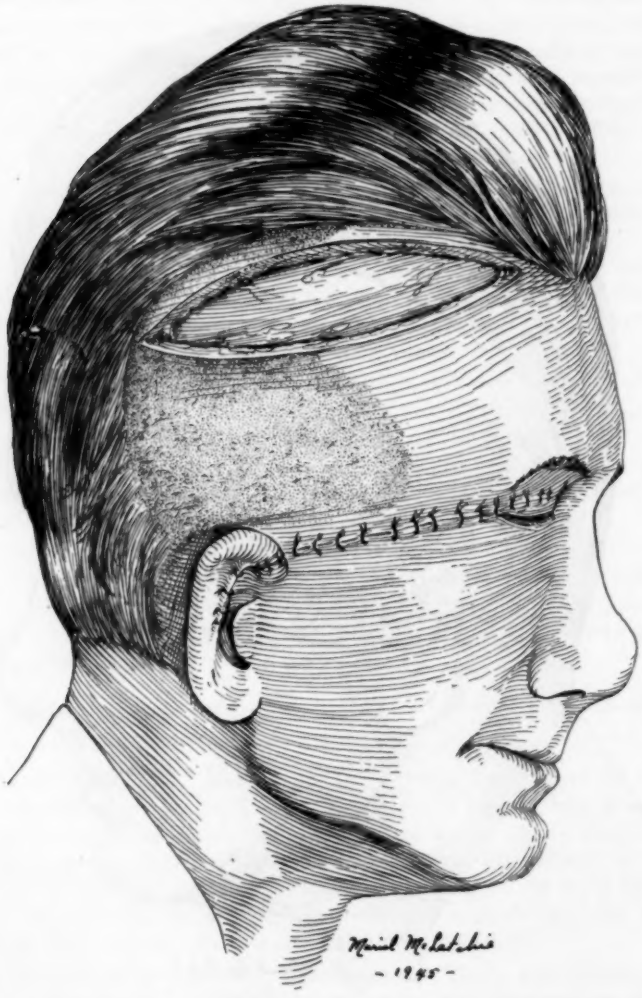

Fig. 5 (case 9).—The dural rent closed by cutis graft patch and muscular aponeurotic structures closed by suturing.

range in the right temporal area, which had caused extensive destruction of the soft tissue, bone, dura and brain. The temporal muscle was extremely frayed, and the gap between the margins of skin was about 4 inches (10 cm.) wide and began at the outer canthus, extending to and involving the right ear, which was torn through into the aural canal. The right eye, but neither of the eyelids, was

destroyed. Excessive comminution and fragmentation of the temporal bone, ragged laceration of the dura and considerable maceration of brain tissue were present.

Operation.—Operation was performed Oct. 28, 1944, by Dr. A. A. Wilson and Dr. Josef Haber. After the dural rent was cleansed by irrigation followed by débridement, it was closed by a cutis graft patch about 1 inch (2.5 cm.) square and the muscular aponeurotic structures were approximated by suturing. A sliding flap of adjacent scalp was brought down and sutured in place so as to cover the

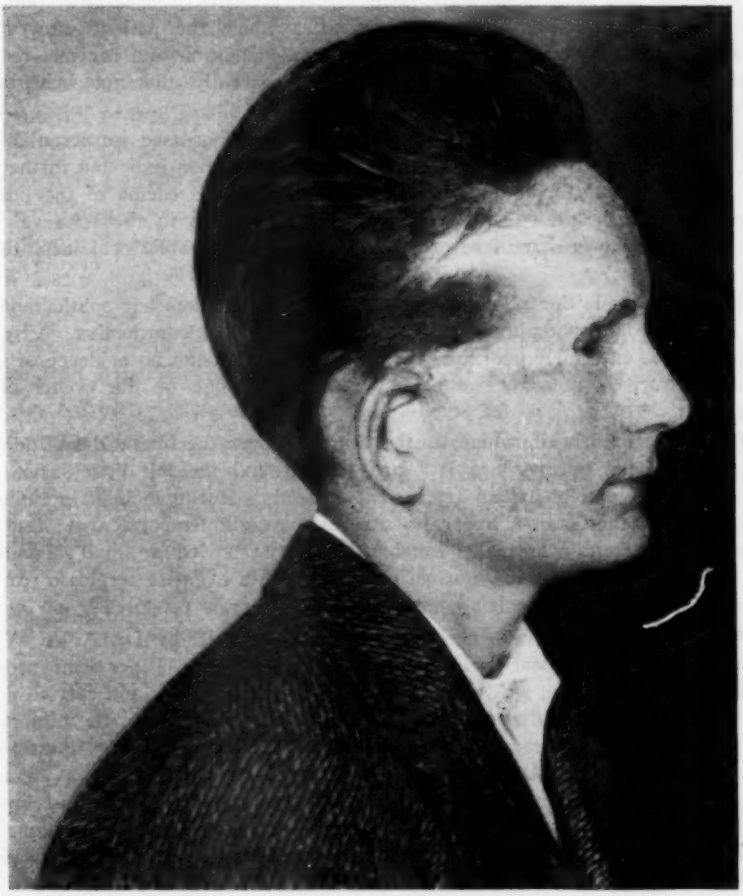

Fig. 6 (case 9).—Final results.

large defect in the skin. The area from which the sliding flap was brought down was covered with a split thickness graft. The result in this case has been extremely satisfactory.

Case 10.—J. B., a white man aged 62, was admitted to the Charleston General Hospital, Jan. 30, 1945, complaining of ringing in his ears and of a painful and pronounced exophthalmos of the left eye. The conjunctiva was intensely injected and edematous. The physician who referred this patient stated that he had fallen down a flight of steps in a hotel Dec. 3, 1944 and had apparently suffered a severe

concussion. In a letter concerning the patient, he stated that examination a short time after the injury showed a laceration of the skin approximately 3 inches (7.6 cm.) long in the right parietal region, pronounced edema of the eyelids and a moderate exophthalmos of the left eye. Roentgenologic examination at that time revealed a linear fracture beginning in the midportion of the right temporal bone and running forward and downward. There were no signs of paralysis. The patient was restless. A slight elevation of temperature was present, and the pulse was rapid. Spinal puncture had been done Dec. 6, 1944, and 15 cc. of reddish fluid was removed, the fluid apparently being under pressure. Subsequent punctures were done until the fluid returned clear, after which the patient showed considerable improvement in his mental and general condition and became, to some extent, cooperative. Later spinal punctures apparently did not bring about further improvement.

Ophthalmoscopic examination showed evidence of increased intracranial pressure, with edema and choking of the left disk. Examination indicated further that there was partial vision in the right eye, with pronounced edema of the lids and conjunctiva of the left. There was apparently no vision in the left eye. The impression noted was that of severe concussion, with probable local laceration of brain substance.

Dr. Wilson made the following notes: "There is complete left ophthalmoplegia with pronounced exophthalmos and extreme edema of the conjunctiva. Vision in the right eye is extremely poor, and the disk is pale, although no evidence of intracranial pressure is noted. The patient remembers none of the events of the accident.

"There is a loud bruit, which can be heard all over the forehead and adjacent areas of the head but perhaps is heard best around the left eye; hence it is assumed that the patient has an arteriovenous fistula. Roentgenologic examination shows nothing other than a linear fracture in the right temporal area; the optic foramen is apparently normal. Lumbar puncture showed a small amount of xanthochromic fluid under low normal pressure, with a negative serologic reaction. A two stage ligation of the left common carotid artery is proposed."

Operation.—Operation was performed on Jan. 31, 1945, by Dr. A. A. Wilson and me. With the patient under anesthesia induced with 1 per cent procaine hydrochloride, an incision was made in the left side of the neck and carried downward so as to expose the common carotid artery just below its bifurcation. A rubber-shod clamp was applied to the carotid artery for twenty minutes, with no untoward reaction. A ½ inch (1.3 cm.) wide strip of cutis was wrapped twice around the common carotid artery and held sufficiently taut almost but not quite to obliterate pulsation. This strip was firmly anchored in position with interrupted cotton thread sutures. At that point in the operation, it was noted that the bruit immediately ceased. The wound was closed in layers with fine silk.

Operation (Second Stage).—On Feb. 8, 1945 the wound of the previous operation was opened and the carotid artery exposed. Three ligatures of heavy black silk were tightly tied around the encircling strip of cutis, after which the weak pulsations distal to the cutis ligature ceased. The wound was closed in layers with fine black silk.

After the first stage operation, the patient's temperature rose to 99.6 F. However, during the entire stay in the hospital his temperature did not rise above 99.8 F. He was discharged February 28, somewhat improved.

Dr. Wilson stated that this patient has continued to show improvement, that there has not been a return of the bruit, that the exophthalmos in the left eye has

entirely disappeared and that the patient has been able to return to his office and to do some work.

Up to the present time, there have been 129 cases in which cutis has been used by my surgical associates and me at the Charleston General Hospital, to wit: 6 cases of epigastric hernia; 27 of abdominal incisional hernia (1 of these was a case of secondary operation for recurrence); 1 of umbilical hernia; 28 of direct and indirect inguinal hernia; 1 of diastasis of the buccinator muscle (glass blower's hernia); 2 of pronounced bulging of the lower abdominal aponeurosis; 1 of herniation of the gastrocnemius muscle; 28 of suspension of the uterine cervix for the relief of prolapse (2 of these were cases of secondary operations for recurrence); 1 of suspension of the urethra for the relief of urinary incontinence (modified Goebell-Stoeckel-Aldredge type of operation); 9 of wobbling knee; 2 of reconstruction of crucial ligaments of the knee; 3 of fracture of the patella; 1 of approximation of the third and fourth metacarpal bones in clawhand; 1 of fracture of the ulna; 1 of ankylosis of the jaw; 3 of sternoclavicular dislocation; 1 of luxation of the acromial end of the clavicle; 1 of repair of a contour defect over a depressed area in the frontal bone; 1 of implantation after sequestrectomy for chronic discharging sinus of the foot; 2 of stage ligation of the common carotid artery; 1 of partial occlusion of the femoral artery for the control of popliteal aneurysm; 3 of replacement of torn dura; 4 of sigmoid colostomy for a bridge to support the bowel, and 1 of implantation for the relief of loss of bowel control due to destruction of the sphincter muscle following the Whitehead method of hemorrhoidectomy.

COMPLICATIONS AND RESULTS

In my personal series of 81 cases, there have been 4 cases of minor infection of the wounds and 3 cases in which a small area of apparent cellulitis developed near the operative incision (patients in these last cases were successfully treated with penicillin therapy). There were 3 instances of moderate serous drainage. In these the patients were treated by protection of the involved area with screen wire shields. Two incisions healed promptly. However, one continued to drain a little for several weeks but did not suppurate. One of the patients in our early case had a hematoma, which healed promptly after removal of the blood clot. There has been 1 death, probably due to anesthesia. The patient, a robust-appearing young man, accustomed to heavy manual labor, died while under ether anesthesia at the close of a brief operation for the cutis graft fixation of a coracoclavicular dislocation; autopsy was not performed. In no case was there loss of the graft.

Among the 48 patients that have undergone cutis graft repair by various other members of our surgical staff, there have been 2 deaths. One

of the patients, an obese woman in poor general condition and suffering from a large, strangulated umbilical hernia, was brought to the hospital at night for an emergency operation. After the strangulated bowel had been released and found to be viable, a cutis graft repair was undertaken. At the end of this procedure, which took a considerable length of time, this patient died, apparently from exhaustion and shock (permission for autopsy was not obtainable). The other death was due to pneumonia incidental to an operation for suspension of the cervix; autopsy in this case showed what was apparently an acute miliary flare-up resulting from an old healed tuberculosis, of which no history was obtainable. Among other cases in this group, there have been 2 rather severe infections of wounds. In 1 of these (in which a double thickness graft was used), a graft was lost. Apparently there has not been a recurrence of hernia in this case. In another case in this group a small abscess developed beneath the graft and adjacent to the previously amputated hernial sac two and one-half years after operation. At the time of incision of the abscess, a specimen was taken for biopsy purposes. This showed the graft to be sound, well vascularized and completely converted into fibrous tissue. The abscess was completely underneath the graft and apparently originated about the external surface of the ligated sac. A culture of the pus showed Staphylococcus aureus. There was no suggestion of recurrence of the hernia. Neither was there anything about the abscess to indicate any connection with an epidermoid cyst. So far, with 2 exceptions, we have been unable to learn of the recurrence of hernia in any case in which a cutis graft repair has been carried out (cases 1 and 5).

The results following cutis graft reenforcement of the collateral ligaments for the treatment of wobbling knee have been good for the most part. Recent reports in 3 cases show excellent function in 1 case; in the second case the result may be classed as good; in the third case a second operation was necessary, after which a slight wound infection developed. The patient in the last case now has about 75 per cent function. Likewise, in the 2 cases of reconstruction of the crucial ligaments the results have been satisfactory.

SUMMARY

We have checked our cases, 129 in number, in which cutis grafts have been used. In this group there were 3 deaths: 1 due to anesthesia, 1 to postoperative pneumonia and 1 to exhaustion and shock after a prolonged operation. In the last-mentioned case, 1 of strangulated abdominal incisional hernia, the procedure possibly could have been handled safely by the stage operation method. There were 2 cases of rather serious infection; in 1 of these a graft was lost. Of the 9

cases of wobbling knee in which cutis graft repair has been done, the results in 6 cases have been reported as good. One patient is still under observation; 1 we were unable to follow up. In the remaining case, the first attempt at operative repair with cutis was unsuccessful. After the second operation, a slight infection developed in the wound. This patient now has about 75 per cent function. In the 2 cases of reconstruction of the crucial ligaments of the knee, the results were good.

CONCLUSIONS

A study of our cases of cutis graft repair shows an operative mortality of 2.32 per cent and a recurrence rate of hernia of 3.2 per cent.

The greatest value of the cutis graft probably lies in its use in the treatment of incisional hernia. Its next greatest field of usefulness probably lies in the cure of prolapse of the uterus. It undoubtedly has considerable value when used for reenforcement and replacement purposes in the repair of ruptured ligaments of the knee. It is of distinct use in the reconstruction of joints and in the stage ligation of large arteries. It probably will be found to be superior material for the stage or permanent ligation of the aorta and for the reenforcement of certain types of aneurysm.

REVIEW OF UROLOGIC SURGERY

ALBERT J. SCHOLL, M.D.
LOS ANGELES
FRANK HINMAN, M.D.
SAN FRANCISCO
ALEXANDER B. HEPLER, M.D.
SEATTLE
ROBERT GUTIERREZ, M.D.
NEW YORK
GERSHOM J. THOMPSON, M.D.
AND
EDWARD N. COOK, M.D.
ROCHESTER, MINN.
AND
VINCENT J. O'CONOR, M.D.
CHICAGO

(Concluded from Page 246)

PROSTATE GLAND

Transurethral Resection.—Latchem and Emmett [26] stated that age is no longer regarded as a contraindication to prostatic operation and that patients of advanced age tolerate transurethral resection almost as well as younger men. During the nine years from 1934 to 1942, inclusive, 345 patients of 80 or more years were treated by transurethral resection at Mayo Clinic. Seventy-four of these patients were 85 or more years of age, and 7 were 90 or more years. On admission, the value for blood urea of 76 of the 345 patients was more than 50 mg. per hundred cubic centimeters, whereas for 20 it was more than 70 mg. per hundred cubic centimeters.

The incidence of associated disease in these elderly patients was high. Forty-two patients were considered poor risks for surgical procedures because of cardiac disease. Two had had cerebrovascular accidents previously, and 1 had paralysis of the lower extremities. Twenty of these patients were suffering from diabetes mellitus. Other associated diseases were too numerous to mention.

The incidence of prostatic malignant lesions in this age group is interesting. In 104 cases (30.1 per cent) the tissue removed at the time of resection was malignant. In another 16 it was felt that the prostatic lesion was definitely malignant, yet the tissue removed was

26. Latchem, C. W., and Emmett, J. L.: Transurethral Resection for Men Eighty or More Years of Age, J. Urol. **53**:482-485 (March) 1945.

reported by the pathologist to be benign. In most of these 16 cases the carcinoma was no doubt deep in the posterior lobe and was not encountered at the time of resection. If these 16 cases are added to the 104, it makes a total of 120, or more than a third of the group, in which the prostate was carcinomatous. This incidence of carcinoma of the prostate in men of this age group, therefore, is more than twice that of an unselected group of patients who undergo prostatic operations.

More than 30 Gm. of tissue was removed in 123 cases (36 per cent), and more than 100 Gm. was removed in 2 cases.

The operative results proved satisfactory. Two hundred and fifty-six patients (74 per cent) obtained excellent results. Another 43 patients (12 per cent) were improved. Fourteen patients secured poor results, whereas the results were not noted on the records of 23 patients. There were 9 deaths in the hospital among these aged patients, a mortality rate of 2.6 per cent. This compares favorably with the mortality rate of 1.2 per cent for the entire group of 7,971 patients subjected to transurethral resection at the clinic for the same period, 1934 to 1942 inclusive.

One of the greatest factors which contributes to the low morbidity and mortality of transurethral resection in this group of aged patients is the brief preoperative and postoperative period of hospitalization. Another factor is that most of these patients are confined to bed for a period not exceeding twenty-four to forty-eight hours after operation. Of the entire group of 345 patients, 206 were hospitalized less than four days previous to transurethral resection and 306 were hospitalized less than one week. After operation 103 patients were confined to the hospital one week or less, and two thirds of the entire group were confined to the hospital for a period not exceeding twelve days. Only 36 patients required postoperative hospitalization for more than twenty-one days.

When the extreme age and the average general condition of these patients are considered, transurethral resection deserves commendation. It has completely changed the prognosis for the aged patient suffering from prostatism. Such a patient may now elect to have surgical relief of his prostatic obstruction, knowing that his chances of relief are extremely good and the operative risk is minimal.

Emmett [27] stated that syphilis of the central nervous system (including locomotor ataxia) is not the important etiologic factor in urinary retention that it previously was supposed to be. Although locomotor ataxia may produce vesical atony in many cases, obstruction of the vesical neck is present in most cases, and in considerably more than

27. Emmett, J. L.: Transurethral Resection in Treatment of True and Pseudo Cord Bladder, J. Urol. **53**:545-564 (April) 1945.

90 per cent of the cases the vesical dysfunction can be relieved completely by transurethral resection of the vesical neck.

Urinary retention in young adults, which formerly was regarded as a "neurogenic bladder" or atypical "cord bladder," is nearly always due to congenital obstruction of the vesical neck. In some cases slight myelodysplasia may be associated with spina bifida occulta. This lesion may produce a mild type of autonomous bladder, with just enough hypertrophy of the detrusor muscle to be manifest as a hyperplasia of the vesical neck. In either case, transurethral resection will relieve the condition. Even though obstruction of the vesical neck is not especially apparent on cystoscopic examination, transurethral resection should be tried, as the obstruction often is not apparent until after the resection is begun.

True "cord bladder," which results from a bona fide lesion of the spinal cord, presents an interesting surgical problem. In practically all cases the detrusor muscle is hypertonic and hypertrophied to some degree, the bladder is trabeculated, residual urine is present and there is some type of active urinary incontinence. On the basis of the theory that the hyperplasia of the portion of the detrusor muscle around the vesical neck may be in part responsible for the residual urine, the possibility of transurethral resection is attractive. The possibilities of such treatment seem to be encouraging.

Emmett has been disappointed in the use of cystometry and has abandoned its use as a diagnostic aid. He feels that more accurate information can be obtained from the patient's history, by physical and neurologic examination, by determination of the amount of residual urine and by cystoscopic examination.

Rodríguez Díaz [28] stated that the general value of transurethral resection is enhanced by refinements in the technic of operation which enable the surgeon to perform it with increasing facility and safety. Employment of a resectoscope that can be operated with one hand, permitting finger tip handling, is advantageous over the more cumbersome and less exact methods of operation that are necessitated by instruments employing pistol grip handles. Postoperative venous bleeding can be effectively controlled by the use of hemostatic agents, such as thrombin applied topically, which are instilled directly into the fossa at the end of the operation. The advantage of this method of controlling postresection bleeding is reflected in the abandonment of frequent vesical irrigation that heretofore has been a necessary part of the postresection routine management.

28. Rodríguez Díaz, L. H.: Some Notes on Advances of the Technique of Transurethral Prostatic Resection, J. Urol **53**:594-599 (April) 1945.

Palomo [29] reviewed 40 consecutive cases in which thrombin was used after transurethral resection. Thrombin (5,000 or 10,000 units diluted in 30 cc. of sterile water) was instilled in the prostatic bed, the three way Cochrane catheter being used. Perfect results were obtained in 33 cases. In the remaining 7 cases, the results were unsatisfactory. The poor results in these cases were due not to the thrombin but to the usual complications of transurethral resection.

The advantages of the use of thrombin after transurethral resection may be summarized as follows: There is no postoperative hemorrhage. The patient is able to be up in a chair the day after operation. It is unnecessary to have a nurse irrigate the bladder every ten or fifteen minutes or to irrigate it continuously, as is done in some clinics. This saving in nursing care is of distinct advantage in a ward. Minimal irrigation results in decreased irritation of the bladder, so that there is no postoperative vesical spasm. There is a saving of equipment and solutions. The postoperative hospitalization is shortened (also of definite importance in a ward).

Prostatectomy.—Rose [30] stated that suprapubic prostatectomy even on senile patients, who may be considered unfavorable surgical risks from the standpoints of senility, cardiovascular disease and injury of the kidney due to back pressure, can be performed with low mortality, little surgical shock or pain, short hospitalization and definitely lessened expense provided that operation is not delayed, all unnecessary trauma and mucosal irritation are avoided and surgical measures are used to prevent bleeding and aid in rapid closure of the bladder.

In 90 per cent of all cases, cystoscopy is followed immediately by one stage suprapubic prostatectomy for relief of infection and urinary obstruction. The operation is uncomplicated by preoperative or postoperative catheterization, vesical decompression or hemostatic catheters, bags and packs. Sulfonamide drugs, penicillin and pentothal sodium are valuable allies. The surgical technic is designed to control hemorrhage and insure early closure of the bladder. Normal vesical function frequently is reestablished within seven to ten days. The majority of patients are dismissed within two weeks.

The two stage operation is used only in the cases in which infection has caused severe damage to the kidney, in cases of cardiac decompensation and in cases in which cystoscopy discloses malformation of the bladder.

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29. Palomo, A.: Evaluation of Thrombin Following Transurethral Resection, J. Urol. **53**:590-593 (April) 1945.

30. Rose, D. K.: Simplified Suprapubic Prostatectomy, J. Urol. **53**:470-474 (March) 1945.

McCrea [31] made a study of 367 cases in which operation was performed for benign hyperplasia of the prostate gland. The following operations were performed: suprapubic enucleation in 217 cases (59.1 per cent), transurethral resection in 135 cases (36.7 per cent) and perineal prostatectomy in 15 cases (4 per cent). These operations were performed by seven urologic surgeons in two hospitals.

Most of the patients were between 60 and 70 years; the average age was 63.2 years. The youngest patient was 43 years, and the oldest patient was 93 years. Of the 367 patients, 307 were in wards and 60 were in private rooms. Fifty-five of the 58 patients who died before they were dismissed from the hospital were ward patients. The causes of death were as follows: cardiac failure in 32 cases, acute pyelonephritis in 9 cases, bronchopneumonia in 6 cases, cerebral hemorrhage in 2 cases, necrosis of the bladder in 2 cases and uremia, pulmonary atelectasis, carcinoma of the stomach, carcinoma of the bladder and embolism in 1 case each. The type of operation that was performed in these 58 cases was as follows: suprapubic enucleation in 36 cases, transurethral resection in 19 cases and perineal prostatectomy in 3 cases. The mortality rate according to the type of operation that was performed was as follows: 20 per cent for perineal prostatectomy, 16.5 per cent for suprapubic prostatectomy and 14 per cent for transurethral resection. The average period of hospitalization was 32.6 days in one hospital and 27.5 days in the other hospital. Of the 367 patients, 31 per cent were in good health five years after they were dismissed from the hospital.

Carcinoma.—Crane and Rosenbloom [32] studied 340 cases of carcinoma of the prostate in order to determine the period of survival and subjective condition of the patients one month and one year after treatment. The patients were treated by nine separate methods. Subjective improvement was present earliest when castration or estrogen or both castration and estrogen were used with transurethral resection. When employed with transurethral resection, castration alone is more effective than estrogen alone; estrogen does not substitute for castration but only reenforces it. Transurethral resection combined with castration and estrogen produced the earliest subjective improvement and the longest median survival time in this series. The treatment of choice in carcinoma of the prostate (except in cases in which the patients are observed in an early stage of the disease) is thorough transurethral resection, castration and continuous administration of diethylstilbestrol.

31. McCrea, L. E.: The End Results of Prostatectomy: A Five-Year Survey, J. Urol. **53**:466-469 (March) 1945.

32. Crane, J. J., and Rosenbloom, D.: Treatment of Carcinoma of the Prostate Gland: A Comparative Study, J. Urol. **53**:411-414 (Feb.) 1945.

Parlow [33] reported 75 cases of advanced cancer of the prostate in which radical perineal prostatectomy was not indicated because the disease was not confined within the capsule of the prostate. Orchectomy was done in all of these cases. In 18 cases, this operation had no effect on the course of the disease and did not produce any relief from pain. Diethylstilbestrol was given in these cases, also without effect. In the remaining 57 cases there was immediate clinical improvement after orchectomy, including relief of all metastatic pain. In 21 of these cases, examination showed regression. Of the 57 patients, 43 had a recurrence of symptoms in eight to thirty months and 22 of these patients had a complete clinical regression of the carcinoma.

Determinations of serum phosphatase were made prior to orchectomy in this series of cases; all but 18 of the 75 patients had a definite elevation of the serum phosphatase; in 1 case the value was 155 units (King-Armstrong). After orchectomy, the value for serum phosphatase paralleled the clinical course; in many cases, a "return" of the carcinoma was indicated by a rise in the value for the serum alkaline phosphatase before digital examination indicated recurrence of the disease in the prostate. Diethylstilbestrol, when given in these cases, relieved symptoms but did not control the progress of the disease.

One patient, a man of 70 years, who had complete clinical disappearance of the carcinoma and a normal concentration of serum phosphatase values after orchectomy, died of pneumonia six months after operation. At necropsy, microscopic examination of the prostate revealed carcinoma cells "enmeshed" in fibrous tissue.

On the basis of the results in this series of cases, the author concluded that, since advanced carcinoma of the prostate may completely regress after orchectomy but later become activated, radical perineal prostatectomy should be done when the carcinoma shows complete clinical regression and when the serum acid and alkaline phosphatase values are normal. It is hoped that at a later date results of such a procedure will be reported.

Tuberculosis.—Diez [34] reported 4 cases of cavernous tuberculosis of the prostate which illustrate how easily this condition can be overlooked by the surgeon or be masked by the presence of tuberculosis in other parts of the urogenital apparatus. The comparatively small number of cases in which the prostate is the sole organ affected by the disease, its lesser gravity in comparison with other lesions and its lack of clinical individuality seem to be the chief reasons why communications on this

33. Parlow, A. L.: Advanced Cancer of the Prostate: A Consideration of the Value of Radical Prostatectomy in Selected Cases, New York State J. Med. **45**: 383-385 (Feb. 15) 1945.

34. Diez, M. M.: Cavernous Tuberculosis of the Prostate, Arch. españ. de urol. **1**:93-98 (July) 1944.

subject are so few. Another reason may be the limited means for its treatment that are at the disposal of either the surgeon or the physician.

Among the facilities for its diagnosis that are now available, none can compare with urethrography by a contrast medium. Rectal palpation gives no satisfactory details of the condition of the lesions, and urethroscopy, equally unsatisfactory, is, in addition, not without danger. As a rule, the roentgenographic images of the cavities in tuberculosis of the prostate are more sharply outlined than those due to other causes. Diez employed a syringe having a capacity of 20 cc. to which is attached a piece of rubber tubing 3 to 4 cm. long. He then slowly injected 15 cc. of the opaque substance, after which roentgenograms were made. If a spasm of the external sphincter of the urethra is suspected, which would prevent passage of the fluid, anesthesia with the hydrochloride of benzoyldimethylaminomethylpropanol (stovaine) is used in advance. In the author's 4 cases, roentgenograms illustrated graphically the presence of tuberculous cavities in the prostate.

Alfonso and Emilio de la Peña [35] reported 8 cases of tuberculosis of the prostate gland, in 7 of which there was coexisting renal tuberculosis. There were signs of urinary tuberculosis in all but 1 case. In this case, the patient had had pulmonary and genital tuberculosis which had apparently healed. The prostate gland was completely calcified when the patient was examined. Total destruction of the prostate ("forebladder") is always the result of renal tuberculosis. Removal of the renal focus usually results in the healing of the prostatic process. So-called "forebladder" results in incontinence of urine, which may disappear spontaneously or may require surgical treatment. Hematogenous invasion of the prostate without involvement of the urinary tract may be benign, although there is always the possibility of tuberculous meningitis as a result of sexual excesses. Diagnosis is readily made by means of cystourethrograms. Treatment of tuberculosis of the prostate should consist in eradication of other foci—especially an infected kidney—and general measures (calcium and vitamins) together with vaccines and intravenous administration of compounds of copper and urea.

Calculi.—From a brief of the literature Nygaard and Weber [36] found that there is "no standard method of approach" in the surgical treatment of prostatic calculi. In the case reported, the patient was a man of 63 years. Urinary symptoms, frequency, nocturia and some dysuria had been present for more than a year; rectal examination showed "a rather pronounced" enlargement of the prostate and crepitation characteristic of prostatic calculi. Preliminary cystostomy was done.

35. de la Peña, A., and de la Peña, E.: Tuberculosis of the Prostate, Brit. J. Urol. **16**:125-132 (Dec.) 1944.

36. Nygaard, K. K., and Weber, E. W.: Total Perineal Prostatectomy for Endogenous Prostatic Calculi, New York State J. Med. **44**:2720-2722 (Dec. 15) 1944.

This was followed by prostatectomy by the perineal route. At operation, one large stone and numerous small ones were found to be lodged in the tissue of the apex of the prostate; this rendered the apex unsuitable for anastomosis with the vesical neck, and a total rather than a subtotal prostatectomy was done. The patient made a good recovery and has since been free from all symptoms. The authors noted that total prostatectomy may be necessary in some cases of diffuse formation of calculi in the prostate, especially if the apex is involved. They said that this seems to be of some significance in considering the surgical approach to be used in such cases.

The occurrence of concretions in the prostatic utricle is not mentioned in the standard textbooks; cases have been reported in the literature, however. If such concretions become impregnated with calcium, they may be considered to be true stones. Penna reported 4 such cases. In the case reported by Dreyfuss,[37] the patient had recurrent urinary obstruction and the prostate was found to be normal (confirmed by biopsy). An attack of acute urinary obstruction more than two years after the prostatectomy caused his death. At necropsy, a stone was found in the prostatic utricle. This was the cause of the urinary obstruction. As there was no abnormal communication between the utricle and either the ureters or the spermatic ducts, it is justifiable to conclude that the stone was primary in the utricle. Several corpora amylacea were found in microscopic sections and indicated that the concretion in the utricle had formed in the same way as prostatic stones do. No obstacle to the flow of urine could be found except the hard prominence at the verumontanum caused by the stone; it must, therefore, be concluded that this small concretion in the utricle was the cause of the recurring urinary obstruction and eventually caused the death of the patient.

PERINEAL FASCIA

Tobin and Benjamin,[38] in discussing Denonvilliers' fascia, stated that this tissue is derived embryologically from two sources of connective tissue (mesenchyme): (1) a layer surrounding the developing prostate and seminal vesicles and another layer around the rectum and (2) connective tissue (mesenchyme) adjacent to the mesothelium of the pelvic cul-de-sac of peritoneum. This peritoneal cul-de-sac extends to the level of the developing levatores ani muscles in young embryos.

Tobin and Benjamin suggested that the fascia around the rectal musculature be designated the posterior layer and that the fibrous mem-

37. Dreyfuss, M. L.: Concretion in Prostatic Utricle Causing Urinary Obstruction, Urol. & Cutan. Rev. **48**:589-592 (Dec.) 1944.

38. Tobin, C. E., and Benjamin, J. A.: Anatomical and Surgical Restudy of Denonvilliers' Fascia, Surg., Gynec. & Obst. **80**:373-388 (April) 1945.

brane, which is derived from the pelvic cul-de-sac of peritoneum, be designated the anterior layer of Denonvilliers' fascia.

In the perineal approach to the prostate, three potential fascial spaces could be developed between the rectum and prostate: (1) between the rectal musculature and the rectal fascia (posterior layer of Denonvilliers' fascia), (2) between the rectal fascia and the anterior layer of Denonvilliers' fascia and (3) between the anterior layer of Denonvilliers' fascia and the fibromuscular covering of the prostate and seminal vesicles.

Since the anterior layer of Denonvilliers' fascia and the fibromuscular covering of the prostate are whitish in appearance and are close together or adherent, either or both of these layers may constitute the glistening layer encountered in the perineal exposure of the prostate.

If the fibromuscular covering of the prostate is perforated by cancer or abscess, the fibrous membrane may prevent direct spread of the malignant growth posteriorly to the rectum and may limit the spread of extravasated pus or urine.

The fascial spaces between the rectum, prostate and seminal vesicles can be separated more readily in the specimens if they are not compressed by urethral or rectal instrumentation in the first stages of the perineal approach.

Wesson [39] said that Buck's and Colles' fasciae only recently have been recognized as anatomic entities. Embryologic, anatomic and experimental studies have proved that Buck's fascia and the tunica albuginea of the penis are separate structures and that Colles' fascia is a distinct entity. The mode of extension of a hemorrhage within Colles' fascia has been determined, and it has been found that abscesses within Buck's fascia are narrowly restricted. Wesson reported 4 interesting cases which illustrated the restricting and protecting powers of the perineal fascia.

TESTIS

Tumors.—Vermooten [40] made a statistical analysis of a series of 62 cases of tumors of the testis seen during a two year period in an army hospital. His analysis indicates that there is a greater incidence of this type of lesion in army personnel than among civilians; however, it is felt that this is due to the easy access which a soldier has to medical advice, to the frequent routine physical examinations and to the fact that a physically fit and active man is especially likely to notice an enlarged, hard or painful testis.

39. Wesson, M. B.: The Value of Buck's and Colles' Fasciae, J. Urol. **53**: 365-372 (Feb.) 1945.

40. Vermooten, V.: Testicular Tumors, Arch. Surg. **50**:63-66 (Feb.) 1945.

Trauma, except for drawing the soldier's attention to the tumor, bears no etiologic relationship to the lesion. A testicular tumor when first seen is frequently mistaken for some other lesion. The most common diagnostic error is to consider the tumor as epididymitis, orchitis or hydrocele. Eleven, or 18 per cent, of the tumors were benign.

In 51 cases of malignant tumor the patients were admitted to the hospital and treatment consisted in radical orchectomy followed immediately by high voltage roentgen therapy. Thirty-six, or 72 per cent, of the 51 patients were living and had no clinical evidence of metastasis when this paper was written. Of these 36 patients, 16 have lived from one year to twenty-five months after operation.

Nation, Edmondson and Hammack [41] stated that 26 cases of interstitial cell tumor of the testis have been reported to date, including the 3 cases which they reported. In 21 cases the tumor was benign, and in 5 cases it was malignant. In 1 of the 3 cases reported by these authors, the tumor was malignant and the patient was 82 years of age. In the other 2 cases the patients were 30 and 34 years of age respectively. One of the patients had gynecomastia which failed to regress after orchectomy was performed. Each of the 6 children in whom tumors occurred had precocious bodily and sexual development. Three (15 per cent) of the adults had gynecomastia.

Interstitial cell tumors of the testis are usually nodular and yellow or yellowish brown. The microscopic picture is characteristic; there are well circumscribed groups of liver-like cells with rather small, round nuclei and many punctate nucleoli, some of which are eccentric.

It is believed that the manifestations of these tumors offer further proof that the interstitial cells of the testis are the primary source of androgen.

Beard and Hewit [42] reported a case of rhabdomyosarcoma of the testis in which the patient was a white man, aged 20 years. The patient had noticed an enlargement of the left testis for several months. On examination, it was found to be approximately 10 by 6 by 6 cm. in size. It was stony hard and not tender. No evidence of metastasis was found. Orchectomy was performed, and microscopic examination revealed a rhabdomyosarcoma. Two months later, roentgen therapy was applied to the abdomen. At this time, a mass was discovered in the upper left quadrant of the abdomen. Metastatic involvement of the thorax occurred, and the patient died approximately seven months after he first was seen.

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41. Nation, E. F.; Edmondson, H. A., and Hammack, R. W.: Interstitial Cell Tumors of the Testis: Report of Three New Cases, Arch. Surg. **48**:415-422 (May) 1944.

42. Beard, D. E., and Hewit, L. W.: Rhabdomyosarcoma of Testicle: A Case Report, J. Urol. **53**:344-346 (Feb.) 1945.

URETHRA

Lesions of the Urethra of Women.—Stevens [43] stated that urethral obstruction in the female usually is caused by stricture, most often at or just within the external urethral meatus. Polyps are also common, but unless they are large they are seldom important factors. Even small growths, however, occasionally may be responsible for such symptoms as urinary frequency, urgency and burning and hematuria and pain.

Stevens reported a case in which a woman aged 80 years complained of urinary frequency and dysuria. She had had a similar condition thirty years previously, at which time urethral dilation had given her relief. Cystoscopic examination revealed multiple polyps and a stricture at the external urethral meatus. She had 1,560 cc. of residual urine. The urethra was gradually dilated so that it would admit a 20 F. sound, and meatotomy was performed. The amount of residual urine decreased to 350 cc. and a further decrease was expected as the vesical walls regained their tonicity.

In a second case, a large calculus was found in the urethra of a woman of 92 years. She had had urinary frequency for many years. Roentgenologic examination revealed a large shadow in this region, and urologic examination disclosed a stricture just inside the external urinary meatus. The stricture was incised, and the urethra was opened through the vagina. Three large calculi, weighing 18.6 Gm., were removed.

Stevens reported another case of urethral calculus in which the patient was a woman aged 42 years. This stone, which was removed through an incision in the urethra, weighed 17 Gm.

Stevens said that the majority of urethral stones originate in the kidneys and descend and become lodged in a diverticulum, in a pouch or behind a stricture in the urethra.

GONORRHEA

Jones [44] stated that the complement fixation test is useful in the diagnosis of gonorrhea only in cases in which microscopic examination or bacterial culture fails to disclose Neisseria gonorrhoeae, in cases in which the history or clinical observations are negative for gonorrhea and in cases in which there is a surgical, social or family problem. The complement fixation reaction may remain positive for months after laboratory and clinical findings are negative. Its use as a routine test must be condemned. Repeated subinfection inoculations of gonococci may cause

43. Stevens, W. E.: Some Interesting Urological Conditions in Women, J. Urol. **53**:378-380 (Feb.) 1945.

44. Jones, W. R.: The Value of the Complement Fixation Test to the Urologist, J. Urol. **53**:393-396 (Feb.) 1945.

the reaction to be positive. There can possibly be a cross fixation from other organisms of the genus Neisseria. The clinician and the technician must collaborate to keep reagents in balance. The test is of value in the hands of the urologist or other clinician who practices individual rather than group medicine and who makes a tentative diagnosis based on the history and the clinical observations and confirms this in the laboratory.

PENICILLIN THERAPY

Fleming,[45] who discovered penicillin, stated that it is a substance produced by a mold, Penicillium notatum. Culture fluid of some kind is put into a bottle, and then mold spores are put on the top of the culture medium. Growth takes place, not in a hot incubator but in the temperature of a rather uncomfortably hot room. The mold forms a thick felt on the top of the clear fluid, which turns yellow. (All the penicillin which is used is yellow, but the pure material has no color at all.) After a week or a fortnight the liquid is poured off, and this contains the penicillin. The treatment of this fluid for the purpose of extraction of the active principle varies with different manufacturers and also keeps on varying with the same manufacturer, because there is as yet no agreement as to the best method. The fluid is finally dried. In the course of purification a great many things are taken away from it which on injection might cause fever of some kind, and there is left a yellow powder, perhaps from 10 to 30 per cent pure. The culture medium varies, and so does the method of extraction; therefore, the impurities vary.

Penicillin has an extremely selective action in inhibiting the growth of some bacteria, whereas it has no effect on others. The more sensitive organisms are staphylococci, streptococci, pneumococci, gonococci, meningococci and Bacillus diphtheriae. Bacillus coli, Bacillus influenzae and many others are not sensitive. When a culture is taken which contains a large number of penicillin-sensitive and penicillin-insensitive organisms, it will be found that the former do not grow and the latter do.

All the old antiseptics were much more active against leukocytes than against bacteria. Penicillin was the first chemical Fleming had ever encountered which acted far more strongly on the bacteria than on the leukocytes. It had no harmful influence on the leukocytes, whereas against certain bacteria the crude culture fluid was more than twice as inhibitory as was phenol.

For use in the body, Fleming stated that sometimes the sodium salt and sometimes the calcium salt of penicillin is employed. To begin with, all the penicillin for injection was in the form of the sodium salt,

45. Fleming, A.: Penicillin in Venereal Diseases, Brit. J. Ven. Dis. **20**:133-136 (Dec.) 1944.

but later the calcium salt was used for intramuscular, intravenous and subcutaneous injection and has been found to be as suitable as the sodium salt. It has certain advantages in manufacture, and some day it may be used generally.

The salt can be applied locally in such a way that the penicillin comes into contact with the organisms. This calls for a certain ingenuity on the part of the surgeon. Consider, however, what happens with the systemic use of penicillin: It cannot be taken by mouth because it is destroyed by the gastric juices; it cannot be given by rectum because it is destroyed by the organisms in the rectum; therefore one must administer it intramuscularly, intravenously or subcutaneously.

Local treatment at present is not used extensively in cases of venereal disease, but in surgical practice it is prominent because it is an extremely economical way of using penicillin. Penicillin can be put on raw surfaces and can be injected into abscesses, boils and similar lesions. It stays in the abscess cavity in appreciable concentration for forty-eight hours or longer.

Penicillinase is a substance which is elaborated by many bacteria and which destroys penicillin. The destruction of penicillin by penicillinase has happened frequently when people have not used enough care in making up their solution to insure its sterility.

Lloyd,[46] in an editorial, stated that the extract of penicillin, although possessing the great advantage of reasonable solubility, is relatively unstable and is susceptible to alterations in *p*H. Thus, the active principle is destroyed by acids, alkalis or heat. It is therefore unsuitable for oral or rectal administration and to be effective must be given parenterally. Various methods, including continuous intravenous drip and intramuscular injection at intervals of three to four hours, have been used and tolerated, with excellent results. In the treatment of gonorrhea these limitations of the method of administration may prove to be no disadvantage, for irregular or inadequate dosage is much more frequently encountered in oral therapy, which is usually dependent on the patient, than in parenteral treatment.

The astonishingly efficient antibacterial properties of penicillin exhibited in vitro in high dilution against cultures of the pyogenic cocci were even surpassed in experiments by Sir Alexander Fleming by its action on cultures of gonococci.

This antibiotic substance seems to possess fundamental characteristics of outstanding practical value. For example, the extracts successfully inhibit the growth of some bacteria in astoundingly high dilutions. It differs from conventional antiseptics in that its activity is not affected

46. Lloyd, V. E.: Penicillin, editorial, Brit. J. Ven. Dis. **20**:131-132 (Dec.) 1944.

by the presence of serum, blood or pus; in addition, it appears to be entirely devoid of any deleterious action on the structures and cells of the human body. If this is so, it clearly attains ideals that have long been postulated for the perfect antiseptic. Many mold extracts are known to possess powerful antibacterial properties, but the extract of P. notatum appears to be unique in also being innocuous to the body tissues. It has been shown that the leukocytes are unaffected by concentrations much greater than those adequate to interfere with the growth of sensitive organisms.

The status of the use of penicillin in the treatment of syphilis is one of keen interest. Preliminary investigations of its effects on this disease in rabbits are said to indicate that it yields excellent results. The use of the compound in the treatment of primary syphilis in man is stated to have resulted in the rapid disappearance of Treponema pallidum and in the speedy healing of chancres; the positive serologic reactions were said to be reversed to negative at a satisfactory rate. However, much more evidence is required before any useful comment can be made. Meanwhile, physicians are awaiting the results of long term studies, which may prove that penicillin will soon have a great part to play in the treatment of early syphilis.

Suchet [47] considered the value of penicillin in the treatment of venereal diseases. He stated that the treatments have varied from single injections at intervals of ten minutes to multiple injections at intervals of a varying number of hours. He has also used the continuous drip method. No matter what the dose has been, his results have been surprisingly good. Nevertheless, in some cases there have been relapses which were not anticipated.

The suitable amount to be used for the treatment of gonorrhea appears to be between 100,000 and 120,000 units. What seems to be important is the time factor. In cases in which 120,000 units have been administered over a long interval, that is, perhaps 15,000 units every three hours until eight doses have been given, the results have been better than they would have been if the total dose had been given at once. Both the calcium and the sodium salts were used.

As a rule, no matter what the original dose, the gonococci disappeared within four hours and in some cases within one and a half hours. The next thing one noticed was that a few hours later the discharge increased in amount and became mucoid. A smear of this profuse discharge revealed masses of leukocytes but no gonococci. Gradually, the discharge cleared up. Some persons have reacted oddly to the treatment; the discharge has continued as long as eight days, and if they

47. Suchet, J.: Penicillin in Venereal Diseases, Brit. J. Ven. Dis. **20**:136-138 (Dec.) 1944.

had been treated with sulfonamide drugs it would have been said that a relapse certainly would occur. These patients eventually were cured.

Organisms can be made resistant to penicillin, but, since gonococci are most susceptible to penicillin, this does not seem likely. Furthermore, the impression is gathered that a patient who previously has been treated with sulfonamide compounds and has failed to respond reacts better to penicillin than do patients who have not been treated with sulfonamide drugs.

Four patients who had gonococcic arthritis have been treated with doses varying from 700,000 to 300,000 units, and a man who received the smallest amount of penicillin—namely, 300,000 units in three days—did best of all. This man had been crippled for three and a half years and had had the usual treatment. Within twenty-four hours after the administration of penicillin had been begun, all the pain disappeared, and he was left with little more than some residual stiffness of his joints.

The question remains as to whether one has, for the first time, a drug which is effective against both syphilis and gonorrhea. If penicillin only masks the symptoms of syphilis and fails to eradicate the disease, one may be faced with a new problem. For example, a patient suffering from both gonorrhea and syphilis, contracted at the same time, might conceivably not be recognized as suffering from syphilis, owing to the action of penicillin in masking the disease.

Another feature worth mentioning concerns the cases in which the treatment has failed. Although patients sometimes failed to respond to a moderate dose of penicillin, when a second course of a similar dose was given they generally got well; furthermore, in cases of gonorrhea if failure was experienced after the first dose and the patients had already been found to be resistant to sulfonamide drugs, they appeared to get well if they were subsequently treated with sulfonamide compounds. It would not do to be too definite, but it is felt that gonorrhea can always be cured by the use of penicillin. With regard to syphilis, however, it remains to be seen whether or not such an optimistic verdict can be pronounced.

Sako, Tilbury and Colley [48] reported 16 cases in which children who had chronic gonorrheal vaginitis were treated by the intramuscular injection of a single dose of 100,000 units of penicillin. Clinical and bacteriologic cure was effected in 15 cases within three days, usually in two days. The remaining patient required further therapy with divided doses of penicillin. Because of its safety and rapid action, penicillin is the drug of choice for the treatment of chronic gonorrheal vaginitis in children. One dose of 100,000 units of penicillin, injected

48. Sako, W.; Tilbury, R., and Colley, J.: One Dose Penicillin Treatment of Chronic Gonorrheal Vaginitis in Children, J. A. M. A. **128**:508-509 (June 16) 1945.

intramuscularly, seems adequate in most cases. Hospitalization is not necessary.

Schmidlapp, Bosworth and Riba [49] said that in approximately 98 per cent of cases in which gonorrhea is resistant to sulfonamide therapy the patients will respond satisfactorily to a total dose of 160,000 units of penicillin injected in doses of 10,000 units every three hours. Smaller doses will increase the percentage of cases in which the results of treatment may be classified as failures. Persistence or recurrence of the urethral discharge during the first ten days after the completion of treatment with penicillin is the most reliable sign that the treatment has failed. During the first seven days after the completion of treatment with 100,000 units of penicillin, bacterial cultures and examination of urethral smears are an unreliable indication of the results of the treatment. In a large number of cases, it is difficult to determine whether N. gonorrhoeae is present in urethral smears obtained after the completion of treatment. This seems to indicate that penicillin limits the growth and multiplication of N. gonorrhoeae. Many authors have minimized the importance of the presence of extracellular and extraepithelial gram-negative diplococci in urethral smears obtained after the completion of treatment with penicillin. Although many new drugs are available, gonorrhea still is difficult to cure. In a small percentage of cases local treatment is necessary.

Horn and Cowper [50] considered the use of sodium penicillin in the treatment of sulfonamide-resistant gonorrhea. The drug was administered to 71 women with gonorrhea. In all but 1 of these, the disease had been found to be resistant to sulfonamide drugs. In 21.6 per cent of the cases, sodium penicillin presumably failed to cure the gonorrhea. It is interesting to note the site of infection in the cases in which the result was a failure. Administration of sodium penicillin failed in 11.6 per cent of the cases in which the infection involved only the lower part of the genital tract and in 35.5 per cent of the cases in which the upper part of the genital tract also was involved. The percentage of failures was lower in cases in which the disease had been present for some time.

Administration of 100,000 units of penicillin presumably failed in 21.4 per cent of the 14 cases of sulfonamide-resistant gonorrhea in which the patients were men. No serious reaction to penicillin was observed in these cases.

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49. Schmidlapp, C. J.; Bosworth, N. L., and Riba, L. W.: The Clinical Use of One Hundred Thousand Units of Penicillin in Sulfa-Resistant Gonorrhea, Brit. J. Urol. **16**:133-143 (Dec.) 1944.

50. Horn, P., and Cowper, H. H.: Sodium Penicillin in the Treatment of Presumably Sulfonamide-Resistant Female Gonorrhea, West. J. Surg. **53**:108-112 (April) 1945.

Early diagnosis and early institution of penicillin therapy are paramount considerations in the control of gonorrhea. In cases in which the patients are women, the diagnosis and cure are difficult and time consuming, and delay caused by a preliminary trial of the sulfonamide drugs may diminish the possibility of cure.

Reynolds and Weyrauch[51] made a clinical study of 509 gonococcic and 26 nongonococcic infections of the urogenital tract treated with penicillin. When the drug was given intramuscularly in doses of 10,000 units every three hours, initial courses of 80,000 units or more produced a cure in more than 98 per cent of the cases of gonococcic infection, regardless of the extent of the urogenital lesion or its chronicity. The administration of 100,000 units was recommended for uncomplicated gonococcic infection and 160,000 units for infections with severe complications. In the experience of these authors, the administration of 100,000 units in five doses of 20,000 units each did not yield as satisfactory results as did the more prolonged schedule. Of the 21 patients who had gonorrheal infection and failed to respond to the first course of penicillin, 20 responded favorably to a second course and only 1 patient required a third course.

In most instances the resolution of gonorrheal arthritis was not accelerated by the use of penicillin, although the urogenital focus was eradicated promptly.

It is now firmly established that penicillin is the most potent drug so far developed for combating gonorrhea. Since it is so highly effective, it should supplant all other forms of chemotherapy in the treatment of gonorrheal infections of the urogenital tract. The advantages which penicillin bears over the sulfonamide drugs are overwhelming: it acts more rapidly and it is more uniformly successful, not only in cases of simple urethritis but also in cases of parenchymatous lesions, blindly ending accessory urethral channels and small periurethral abscesses which respond poorly, if at all, to sulfonamide compounds. It is as effective in the chronic lesions as in the acute processes, another point of superiority over the sulfonamide drugs, and it is completely nontoxic in doses far exceeding those required for therapeutic purposes. Its few points of inferiority are that at present penicillin lacks permanent stability and must be administered parenterally.

The role of penicillin in the treatment of nongonococcic urogenital infections is less impressive. The drug is useless against the colon bacillus, which accounts for a large proportion of urogenital infections. It has proved disappointing against the large group of nonspecific infec-

51. Reynolds, L. R., and Weyrauch, H. M.: The Use of Penicillin in the Treatment of Urogenital Infections: A Clinical Study of Five Hundred and Nine Gonococcal and Twenty-Six Non-Gonococcal Infections of the Urogenital Tract, J. Urol. **53**:614-629 (April) 1945.

tions of the urethra, prostate and epididymis. Apparently, the widest application is against the coccic infections, especially those of the kidney and perinephric space. In these cases its contribution may prove invaluable. Since the amount of penicillin required to kill staphylococci is considerably greater than that required to kill gonococci, much larger quantities of the drug are indicated.

Doolittle and Marshall [52] reported that in a series of 294 cases of sulfonamide-resistant gonorrhea, 100 per cent of the patients were cured with penicillin. Of 246 patients treated with only 50,000 units, 95.5 per cent were cured. Of 48 patients treated with an initial course of 100,000 units, only 1 failed to obtain a cure. All patients in both groups were cured with a second course of 100,000 units.

UROLITHIASIS

Milbert and Gersh [53] said that the incidence of urolithiasis was high among soldiers. Of the first 100 patients who were admitted to the urologic section of the Borden General Hospital, 21 had evidence of calculi, an incidence of more than 20 per cent. Fifteen of the succeeding 80 patients had evidence of the disease. This preserved the ratio of 1 to 5.

Milbert and Gersh noted that calculous disease of the urinary tract appears to be present at a much earlier period of life than is generally believed. Of 54 patients with ureteral calculi, 35, or 64.8 per cent, were 20 to 30 years of age. Sixteen, or 29.6 per cent, were between 30 and 40 years. The average age of the entire group was 28.2 years. Of 27 patients with renal calculi, 14, or 51.8 per cent, were 20 to 30 years. Ten, or 37 per cent, were between 30 and 40 years. The average age of the group with renal calculi was 27 years.

Patients requiring orthopedic treatment frequently predominate in wartime casualties, and the ever present danger of calculus formation due to recumbency or to calcium-phosphorus imbalance with multiple or extensive oblique fractures must be guarded against constantly.

A less common cause of formation of calculi and one that may assume some degree of importance because of the presence of troops in Africa is infestation with Bilharzia haematobia (Schistosoma haematobium). Calculi are formed about nuclei of the ova, blood clots or papillomatous tissue created by the action of the ova.

An observation worthy of note was the significantly low incidence of urolithiasis among Negro troops. In only 2 of the 84 cases reported were the patients Negroes. Urethral calculi were present in those cases.

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52. Doolittle, L. H., and Marshall, H. B.: Penicillin Treatment of Sulfonamide-Resistant Gonorrhea, J. Urol. **53**:634-637 (April) 1945.

53. Milbert, A. H., and Gersh, I.: Urolithiasis in the Soldier, J. Urol. **53**:440-446 (March) 1945.

The findings of Milbert and Gersh are consistent with the observations of other authors. In World War I, only 52 instances of nephrolithiasis were recorded among 286,548 Negro troops. The incidence per thousand Negro troops was 0.18, in contrast with an incidence of 0.41 among white soldiers.

Keyser,[54] in discussing urolithiasis, stated that one must revert to the concept that calculus formation is one and only one of the many types of crystalline deposition, or lithiasis.

A region of degenerative change in the urinary epithelium is a sine qua non for calculus formation. This mucosal necrobiosis is usually situated in the collecting tubules of the pyramids in the wall of the ureter, in the bladder or in the prostatic tubules. In such regions, crystalline matter may be deposited. If it is walled off, the process is encapsulated and growth does not occur. However, if the crystalline deposit in a papilla or elsewhere becomes exposed through surface ulceration to the urinary stream, further crystalline deposition takes place at this site and grows until the mass breaks away into a calyx or the pelvis and a concrement ensues.

When there is such a calcific or crystalline deposition in tissue, hyperexcretion of crystalloids, as in hyperparathyroid disease, in gout or in sulfanilamide poisoning, affords an abundance of stone-forming material to be deposited thereupon and greatly enhances the chance of stone formation, as the solution mechanism of the urine is upset. Likewise, infection, especially with urea-splitting micro-organisms, will supply an excessive amount of insoluble crystalline matter to be deposited at such sites.

Stasis, the urinary p_H, the urinary concentration and the body temperature are factors which do not produce calculus themselves but are of the utmost importance in modifying the rate of growth of the stone. Also, they modify the composition, the shape and the size of the stones. Stasis may irritate the wall of the pelvis, ureter or bladder and satisfy conditions for stone formation.

Flocks [55] stated that certain conditions are definitely known to predispose to stone formation. This is especially true if immobilization of the patient takes place, if portions of the urinary tract are paralyzed and if obstruction and infection of the urinary tract occur as a result of trauma.

In a previous report based on chemical and clinical studies in 279 cases of calcium urolithiasis, Flocks suggested that (*a*) calcium urolithiasis occurs frequently in these conditions because of the associated hypercalcinuria, urinary infection and urinary stasis and (*b*) the

54. Keyser, L. D., in discussion on Flocks [55] and Milbert and Gersh,[53] p. 447.

55. Flocks, H. R.: The Preventive Treatment of Calcium Urolithiasis: The Important Rôle of Early and Frequent Roentgenographic Examinations, J. Urol. **53**:427-439 (March) 1945.

mechanism of this phenomenon is much initial precipitation of calcium phosphate resulting in the formation of many small calculi in the first few weeks of recumbency and stasis.

Further experience with cases of calcium urolithiasis serves to emphasize the importance of frequent and early roentgenographic check-up examinations whenever conditions predisposing to calcium urolithiasis are or have been present.

The three fundamental causes of calcium urolithiasis are hypercalcinuria, urinary stasis and infection of the urinary tract. If recumbency is necessary, hypercalcinuria cannot be prevented. The only thing that can be done to counteract this is dilution of the urine by maintaining a large urinary output. Stasis of some degree cannot be avoided when damage of the central nervous system is present. Infection cannot be completely prevented if catheters and drainage tubes are necessary for adequate drainage of the urinary tract. Therefore, in spite of painstaking treatment, calcium stones may form.

The preventive treatment of calcium urolithiasis in patients who are immobilized consists essentially in six measures: the maintenance of a large fluid output, the control of diet, the control of urinary stasis, the control of infection, the continuation of treatment for three months after immobilization has been discontinued and frequent roentgenographic checkup examinations.

Early diagnosis, which is best made by frequent roentgenographic examination, is of considerable importance because such stones in their early stages are loose concretions which can in many cases be broken up and washed out or caused to pass before any extensive damage to the urinary tract has occurred and without the need of an open surgical procedure. It is important because the stones may be silent and produce no manifestations of their presence until they are large, coalescent masses and have produced extensive renal damage which may require an open surgical procedure for repair or may be so extensive that the damage is irreparable.

The method of roentgenologic examination usually used at the University Hospital consists of a plain roentgenogram and another one made twenty minutes after the intravenous injection of 20 cc. of diodrast. The examination is made one month after the onset of the predisposing condition. If stones do occur or if other complications, such as infection of the urinary tract, occur, the roentgenographic examinations are made more frequently.

Harrison, Botsford and Pierce [56] stated that the problem of urinary calculi represents an important aspect of military medical practice in

56. Harrison, J. H.; Botsford, T. W., and Pierce, F. R.: The Management of Urinary Lithiasis in an Army General Hospital, J. Urol. **53**:282-294 (Feb.) 1945.

the tropics. The soldier who has passed a calculus or who has been relieved by operative removal of a calculus should be instructed as to the importance of high fluid intake to prevent recurrence. Adequate consumption of salt is important in the body's conservation of water in the tropics. If practicable dietary measures should be instituted as prophylaxis against formation of calculi. The patient having bilateral or recurrent renal lithiasis should not return to tropical service. Persistence of infection or the presence of an obstructive congenital anomaly of the urinary tract is a contraindication to further tropical service. Sixty-six of 100 consecutive patients who were admitted to the hospital because of urinary lithiasis were returned to and remained at full military duty; 9 were able to do limited duty, and 25 were returned to the United States. Thirty-five patients were relieved of calculi as a result of cystoscopic manipulation; of 31 who required no operative intervention 15 passed calculi spontaneously. Thirty-seven open operations were performed on the remaining 34 patients.

UROGRAPHY

Pritchard,[57] in discussing intravenous urography, stated that the "standard" dose of intravenous dye is inadequate. Two to three times the recommended quantity may be given to average adults, double this amount to children and three times this amount to infants. To avoid confusion, the dose should be expressed in grams of iodine because of its varying percentage in the products used.

The patient's preliminary concentrating power measures one essential renal function and forecasts the probable radiodensity of resulting urograms. It permits individual modification of dosage for optimal density or decides against application of the method.

Inefficiently concentrating kidneys usually produce dense urograms with sufficient dye. Rarely, they produce more dilute urine and paler roentgenograms. Some poorly concentrating kidneys show temporary displacement by the iodine molecules of other crystalloids. More efficient kidneys do not show this but increase the specific gravity by addition of the heavy iodine molecules.

The safety and almost universal applicability of excretory urography have been demonstrated.

Draper and Siceluff [58] described a procedure for visualization of the bladder and urethra. Five separate roentgenograms of the lower part of the urinary tract are made: (1) an air cystogram is made; (2)

57. Pritchard, W.: Notes Regarding Intravenous Urograms, Based on Two Thousand Series in Eighteen Years, J. Urol. **53**:387-392 (Feb.) 1945.

58. Draper, J. W., and Siceluff, J. G.: Excretory Cysto-Urethrograms, J. Urol. **53**:539-544 (April) 1945.

a urogram is made while the patient is voiding the contrast medium; (3) the patient is asked to stop voiding and a third urogram is made; (4) the next urogram is made while the patient is voiding against obstruction produced by a penis clamp, and (5) the patient is allowed to empty his bladder and a final urogram is made to demonstrate any residual urine which may be present.

INJURY OF THE GENITOURINARY TRACT

Reynolds [59] stated that injuries of the urogenital tract in war present the same problems as those in civilian life. Injuries of the kidney require surgical intervention only when hemorrhage is extensive enough to demand control. In such cases, nephrectomy usually has to be done to assure hemostasis. Suprapubic puncture of the bladder to establish drainage is the procedure of choice in most cases of rupture of the urethra or vesical paralysis due to injury of the central nervous system. The present means of controlling shock and the efficiency of the urinary antiseptics available make it possible to save more patients with severe injuries to the urogenital tract than formerly was possible.

CHANCROID

Allison [60] stated that chancroid is a common venereal infection in women as well as in men although not so immediately or easily recognizable in women. Lesions may be recognized in practically all patients formerly designated as carriers. History of definite contact and subsequent culture will establish an accurate diagnosis. Search of stained smears will reveal the bipolar Bacillus of Ducrey. The Ducrey cutaneous test is helpful but not diagnostic alone. Venereal diseases frequently occur in multiples. In each case the examiner must ask not which but how many diseases the patient has. Other venereal diseases alter, accelerate and modify the progress and clinical characteristics of and the patient's reaction to a given single infection. Women tolerate chancroidal infection and are more resistant to the destructive lesions than are men. Sulfathiazole is especially valuable in the treatment of chancroid.

URINARY OBSTRUCTION

Riba and Schmidlapp [61] stated that in the army urinary obstruction is a common lesion which most frequently involves the upper part of the

59. Reynolds, L. R.: War Injuries to the Genito-Urinary Tract: A Brief Review of the Types of Injuries Observed in One U. S. Naval Base Hospital in the Pacific, J. Urol. **53**:419-421 (Feb.) 1945.

60. Allison, G. G.: Chancroid Disease in the Female, J. Urol. **53**:503-506 (March) 1945.

61. Riba, L. W., and Schmidlapp, C. J.: Surgical Treatment of Urinary Obstruction in Army General Hospitals, Surg., Gynec. & Obst. **80**:368-372 April) 1945.

ureter, vesical neck and urethra. In the majority of cases the lesions existed prior to the induction of the soldier into the service. The prostatic diseases of senescence are uncommon. Ample opportunity exists in the army to correct congenital obstructive lesions early with minimal morbidity and mortality. In maladjusted and inadequate patients in military service, operation for lesions which existed prior to induction, unless emergent, is usually contraindicated.

PROGRESS IN ORTHOPEDIC SURGERY FOR 1944

A Review Prepared by an Editorial Board of the American Academy of Orthopaedic Surgeons

XVIII. Infections of Bones and Joints Exclusive of Tuberculosis

PREPARED BY LENOX D. BAKER, M.D., DURHAM, N. C.

AS HAS been true in all the years of the war, the literature for 1944 contained relatively few articles on osteomyelitis excepting those dealing primarily with reports of cases in which penicillin therapy and chemotherapy were used. When a new antibiotic is introduced there is always a flood of such reports, with few articles that rationalize the changes that are necessary to allow the new drug or procedure to take its proper place in the over-all picture of the disease under discussion. Certainly penicillin is a valuable adjunct in the treatment of osteomyelitis, and its presence makes necessary a reevaluation of previous ideas in regard to treatment of this disease. The antibiotic value of penicillin has been established. Studies are now needed to determine its side actions on the reticuloendothelial tissues, the hemopoietic system, the glands of internal secretion and the other factors associated with the response of the body to the administration of this organic substance.

Anderson, Howard and Rammelkamp [622] report a series of 40 cases of chronic osteomyelitis treated with penicillin. In 25 of the cases there was a follow-up of one year or more. The patients ranged in age from 14 to 74 years. Duration of the infection ranged from two months to forty-nine years. In 19 cases draining sinuses had been present a year or more. The drug was used intramuscularly, intravenously and locally. In 31 cases only one course of penicillin was given. The authors express the opinion that local therapy alone was not of material benefit but that when combined with systemic therapy it may be advantageous, The total dosage of the drug ranged from 400,000 units to 5,500,000 units. Duration of the treatment was from two to fifty-six days. Surgical treatment was used in 12 cases. Nine patients received a second course of penicillin therapy because of relapses. The status of the patients at the time of the report was as follows: infection arrested (no relapse) 23; spontaneous arrest after relapse 5; relapse (lesion draining) 4; improvement 2; no improvement 5, and

622. Anderson, D. G.; Howard, L. G., and Rammelkamp, C. H.: Penicillin in Treatment of Chronic Osteomyelitis: Report of Forty Cases, Arch. Surg. **49:** 245-257 (Oct.) 1944.

death 1. The authors conclude (1) that penicillin is the most effective chemotherapeutic agent for the treatment for staphylococcic infection and (2) that primary closure following sequestrectomy or evacuation of an abscess of a bone is a safe and satisfactory procedure for patients who are receiving penicillin.

Ericksen [623] reports the use of penicillin in the treatment of a white man with osteomyelitis who had been given sulfadiazine and sulfathiazole for twenty-five days. Cultures of the blood remained positive throughout the entire period. Penicillin was started. All cultures of the blood made after penicillin therapy was started were negative. The temperature subsided, and the patient was discharged from the hospital at the end of two weeks, apparently cured of his infection.

Mowlem [624] reports 20 cases of osteomyelitis of the mandible treated with penicillin; 16 of the patients had well established and gross infections. Penicillin was used in conjunction with radical surgical treatment and primary closure followed by irrigation with penicillin. Four of the cases were postoperative cases in which it was thought that penicillin contributed to a speedy and uncomplicated convalescence. Mowlem reports 1 case, that of a soldier aged 53 with a draining sinus in the iliac crest. One thousand units of penicillin were injected daily for ten days, with no change in the sinus or its bacterial flora. At operation a sequestrum was found in a cavity lined with fibrous tissue. The author concludes that penicillin will not give bacteriologic control in the presence of sequestrums and it is not a substitute for operation.

Gaul [625] reports 6 cases of osteomyelitis in which penicillin was used.

Pittman [626] reports on a patient treated nineteen days with sulfathiazole for osteomyelitis of the femur, without improvement. On the nineteenth day treatment with penicillin was started. Recovery was rapid, beginning on the third day after penicillin was started. Pittman stated the belief that had the patient received penicillin earlier destruction of bone would have been prevented, surgical intervention would have been unnecessary and a shorter convalescence could have been expected.

Riddell [627] reports a case of osteomyelitis in which dislocation of the hip was treated by penicillin.

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623. Ericksen, O. C.: Staphylococcus Albus Osteomyelitis and Septicemia Treated with Penicillin, J. A. M. A. **124**:1053-1054 (April 8) 1944.

624. Mowlem, R.: Surgery and Pencillin in Mandibular Infection, Brit. M. J. **1**:517-519 (April 15) 1944.

625. Gaul, J. S.: Treatment of Six Cases of Osteomyelitis with Penicillin, Bull. Charlotte Mem. Hosp. **1**:28-30 (March) 1944.

626. Pittman, M. A.: Penicillin in Treatment of Osteomyelitis and Other Infections: Case Report, Virginia M. Monthly **71**:66-70 (Feb.) 1944.

627. Riddell, T.: Penicillin in Acute Osteomyelitis: Report of Case, Nebraska M. J. **29**:284 (Sept.) 1944.

Robertson [628] reports 34 cases of osteomyelitis in which penicillin was used; 9 patients received the drug systemically and 25 received it locally. Of the 9 patients treated systemically, 7 were children with acute osteomyelitis. The results were most satisfactory. The systemic therapy in 2 cases of chronic infection was of only temporary benefit. Local applications of penicillin in cases of chronic bone sepsis proved disappointing. The author concludes that sequestrums and foreign bodies must be removed or the sinuses will not heal.

Schaff and Ivey [629] review penicillin therapy for osteomyelitis.

Kenney [630] reviews the literature on acute osteomyelitis and compares the results reported before and after the introduction of the sulfonamide compounds. The average mortality rate without chemotherapy was 23 per cent. The mortality rate with chemotherapy averaged 3.5 per cent. The author compares the local results with and without chemotherapy and concludes that the sulfonamide drugs have not proved of value so far as the local pathologic process is concerned.

Key [631] discusses the use of the sulfonamide drugs in chronic osteomyelitis and reports 101 cases in which the patients had been given sulfathiazole for five days preceding surgical treatment. At operation, all infected soft tissue, dead bone and sequestrums were excised. The wound was dusted with sulfathiazole powder and closed, as recommended by Dickson, Dively and Keene, who had reported 82 per cent primary healing in a similar series. Sulfathiazole was administered orally for fifteen days after operation. Wounds in 60 cases healed by primary intention. The 101 cases in this series were not a selected group as were the cases reported by Dickson, Dively and Keene. The author concludes that this method of treatment should be used in all chronic pyogenic bone infections.

Baker, Schaubel and Kuhn [632] report a series of cases, with controls, in which they compare the end results of the treatment of acute osteomyelitis with sulfathiazole, sulfadiazine or sulfathiazole and sulfadiazine, with and without operation. They studied 56 cases, in 30 of which patients were treated with surgical drainage; when last seen 21 patients

628. Robertson, I. M.: Penicillin in Bone Infections, Brit. M. J. **1**:519-521 (April 15) 1944.

629. Schaff, B., and Ivey, H. T.: Penicillin in Treatment of Osteomyelitis, M. Bull. Vet. Admin. **20**:369-372 (April) 1944.

630. Kenney, W. E.: Prognosis in Acute Hematogenous Osteomyelitis With and Without Chemotherapy, Surgery **16**:477-484 (Oct.) 1944.

631. Key, J. A.: Sulfonamides in the Treatment of Chronic Osteomyelitis, J. Bone & Joint Surg. **26**:63-70 (Jan.) 1944.

632. Baker, L. D.; Schaubel, H. J., and Kuhn, H. H.: Open Versus Closed Treatment of Acute Osteomyelitis: Clinical Report on Use of Antitoxin and Sulfonamide Drugs With and Without Early Drainage, J. Bone & Joint Surg. **26**:345-349 (April) 1944.

in this group had active draining sinuses and 9 had healed lesions. Twenty-six of the patients were treated by aspiration; when last seen 21 of the 26 had sinuses that never drain and in 4 sinuses that drained spontaneously. All 56 patients were treated with sulfathiazole, sulfadiazine or sulfathiazole and sulfadiazine. They all had the same supportive care, the only difference in the therapy being in the use of surgical drainage and the use of aspiration.

These authors list the standing orders at Duke Hospital for patients admitted with a diagnosis of acute osteomyelitis as follows:

1. A complete examination, including roentgenograms of the parts affected and flat plates of the chest, is to be made, additional roentgenograms to be taken as indicated.

2. Hemoglobin determination, and red-blood-cell and white-blood-cell counts are to be done, the latter to be a differential count to estimate the relative percentage of mature and immature polymorphonuclear cells. The hemoglobin and differential white-blood-cell count are to be repeated daily for the first week, then every other day during the acute stage of the disease.

3. Adequate doses of staphylococcus antitoxin are to be given, if the white count indicates that the patient is not producing sufficient antitoxin to combat the toxaemia.

4. Sulfathiazole or sulfadiazine is to be given, the amount to be determined according to dosage chart. (Until recently the dosage of the sulfonamide drugs was fairly well established, and it was felt that a dose sufficient to maintain a blood level of four to eight milligrams per 100 cubic centimeters was ample. It may be, however, that this level is too low. Robertson has used larger doses of the drugs—four to six grains per pound of body weight per day—without undue signs of toxic effect from the drugs, and, apparently, with earlier control of the disease than is seen with the smaller doses.)

5. Daily urine examinations are to be made for the first week and then every other day as long as the sulfonamides are given. (The first urine examination is made immediately upon admission, as the patient may have had large amounts of a sulfonamide before admission.)

6. Sufficient intravenous fluids are to be given in the form of physiological solution of sodium chloride, with 5 per cent to 10 per cent glucose, to combat dehydration and to supply the needed chlorides and carbohydrates.

7. The patient's blood is to be matched for blood transfusion, and transfusions of 150 to 200 cubic centimeters are to be given daily or as indicated.

8. A staphylococcus titer is to be done on admission and following transfusion from each new donor. A staphylococcus titer is also done on all donors.

9. Blood cultures are to be planted on admission and daily thereafter, or until the cultures have been negative on three successive days.

10. Sedative is to be given as indicated to keep the patient comfortable and at rest.

11. Violet-ray therapy is to be given daily after the patient is well enough to be transported to the Physical Therapy Department.

12. The affected part is to be put at rest in the best position for function. Traction, splints, or cast should be used to suit each case.

13. Normal saline compresses are to be applied to the involved area or areas.

14. Abscesses are to be aspirated and cultured. Following aspiration, the abscess is to be gently irrigated with sterile normal saline solution until the washings are clear. One or two grams of microcrystal solution of sulfathiazole is to be instilled with the last washing, and the abscess is then to be re-aspirated as completely as possible. Additional irrigations and local instillation of sulfathiazole are to be done as indicated.

15. The patient is to be put on a high-vitamin diet as early as possible.

16. Accessory vitamins are to be given (intravenously if necessary) as follows (dosage for a child ten years of age or older, smaller dosage for younger patients):

Ascorbic acid, fifty milligrams three times a day,

Thiamine chloride, five milligrams three times a day,

Nicotinic acid, twenty-five milligrams twice a day (preferably the amid form to avoid flushing).

Oleum percomorphum ten drops twice a day (cod-liver oil is preferable if the patient can tolerate it).

They discuss the use of accessory vitamins as follows:

It is well established that a patient with an infectious disease may rapidly become deficient in vitamin C and that he requires larger amounts of the vitamin to keep saturated. Also, it has been shown that new capillaries fail to form in fibrin clot in the absence of sufficient vitamin C. These facts make the giving of an ample dose of ascorbic acid so important to osteomyelitic patients. Vitamin A must be supplied if epithelialization is to take place, and vitamin D is necessary for the bone repair. The various B vitamins are essential as stimulators of the appetite and as aids in the patient's general well-being.

Sixteen of the patients gave a history of having had sulfonamide therapy before their admission to the hospital. Of the 16 patients, 3 had positive cultures of the blood and 13 had negative cultures. Of the 3 who had positive cultures, 1 had received a sulfonamide drug for one day and 1 for three days. One had received sulfanilamide for eight days. (It is known that sulfanilamide is contraindicated in staphylococcic infections.) Twenty-two of the patients had received no sulfonamide therapy before admission. Sixteen of these had positive cultures of the blood, and 6 had negative cultures. There was no record as to sulfonamide therapy before admission on 10 of the patients. Six had positive cultures of the blood, and 4 had negative cultures. The authors do not include patients treated with penicillin therapy but state, "Penicillin, another bacteriostatic substance, has been found to be effective in combatting the staphylococcus, but until penicillin or a like substance has become available, sulfathiazole, sulfadiazine, or both are our best bacteriostatic drugs." (The authors are now using penicillin.) The paper lists the following conclusions:

1. A well-planned, useful, supportive routine is necessary for osteomyelitic patients.

2. Staphylococcus toxins can be neutralized *in vivo* by antitoxin prepared from Burky's Ha strain of hemolytic staphylococcus aureus.

3. The mortality rate in hemolytic staphylococcus aureus osteomyelitis can be lowered by the use of sulfathiazole, sulfadiazine, or both.

4. The morbidity of the disease can be reduced if surgical drainage is not used.

Meyerding [633] discusses sclerosing osteitis as one of the inflammatory diseases which must be considered in the differential diagnosis of benign and malignant lesions of bone. The paper quotes Garré's original description of the process and then discusses the acute stage of sclerosing osteitis and the chronic stage. In the differential diagnosis must be considered syphilis, sarcoma, Paget's disease, ossifying hematoma, osteitis fibrosa cystica, Ewing's sarcoma and metastatic carcinoma. Meyerding states the belief that the treatment is surgical and that saucerization is preferable to drilling or other procedures. [ED. NOTE (L. D. B.).—This is an excellent discussion of sclerosing osteitis, and if for no other reason except to get the points in the differential diagnosis the article should be read *in toto*.]

Siler [634] discusses the management of infections of the upper extremities. He points out the value of early and adequate incision and drainage, the use of sterile technic, including the wearing of a mask when dressing the wounds, and states that a good functional result and not just a nicely healed wound is the ideal goal.

In an article which was not available for review,[635] Gierc reports on the action of beer yeast on staphylococcic infections.

Cutait and Musa,[636] in another article which was not available for review, report the use of refrigeration anesthesia in therapy for osteomyelitis.

Chavez,[637] in still another article not available for review, discusses the use of the inductotherm in the treatment of osteomyelitis.

Frank [638] reports the case of a 43 year old white man in whom as a sequel of a staphylococcic infection of a finger metastatic lesions developed, including acute osteomyelitis of the odontoid process with a pathologic fracture. Frank discusses the differential diagnosis of osteomyelitis of the vertebrae and reviews the literature. The article by

633. Meyerding, H. W.: Chronic Sclerosing Osteitis (Sclerosing Non-Suppurative Osteomyelitis of Garré): Differential Diagnosis, S. Clin. North America **24**:762-779 (Aug.) 1944.

634. Siler, V. E.: Management of Injuries and Infections of the Upper Extremities, J. A. M. A. **124**:408-412 (Feb. 12) 1944.

635. Gierc, B.: Action of Beer Yeast on Staphylococcic Infections: Use in Chronic Osteomyelitis, Rev. méd. de la Suisse Rom. **63**:788-794 (Oct. 25) 1943.

636. Cutait, D. E., and dos Santos Musa, F.: Refrigeration Anesthesia in Osteomyelitis, Resenha clin.-cient. **13**:279 (July 1) 1944.

637. Chavez, N.: Treatment of Osteomyelitis by Inductothermy, Bol. méd. d. Hosp. inf., México **1**:31-40 (July-Aug.) 1944.

638. Frank, T. J. F.: Osteomyelitis of Odontoid Process of Axis (Dens of Epistropheus), M. J. Australia **1**: 198-201 (March 4) 1944.

Makins and Abbott is recommended as an excellent paper on the subject; it was published in the *Annals of Surgery* (**23**: 510, 1896).

Arden and Derrick [639] report a case of osteomyelitis of the odontoid process of the axis.

Neuhof and Arnheim [640] present a comprehensive consideration of infections of the retroperitoneal tissues and list a clinical classification, dividing the cases as to localized form and as to diffuse form. Under the localized form they list the following types of abscesses: (1) lumbar, (2) iliac, (3) subphrenic only and (4) pelvic only. This classification is discussed according to (1) anatomy, (2) pathogenesis, (3) pathology, (4) bacteriology, (5) clinical manifestations, (6) diagnosis and (7) treatment and results. Brief reports of cases include 25 cases of lumbar abscesses, 23 of iliac abscesses and 17 of diffuse infections. The difficulty of accurate diagnosis is mentioned, and examination with the patient under anesthesia to allow accurate palpation without interference from protective muscle spasm is recommended. In only 25 per cent of their cases did symptoms suggest retroperitoneal abscess. [ED. NOTE (L. D. B.).—This is a good discussion of an interesting subject. The paper warrants a full study.]

Raventós Moragas,[641] in a paper not available for review, reports a case of primary osteomyelitis of the patella.

Rountree [642] made a survey of all cases of osteomyelitis seen in the University of Oklahoma School of Medicine and Crippled Children's Hospital and found 714 patients with osteomyelitis admitted from 1931 to 1939. Of this group, 5 per cent showed osteomyelitis of the fibula only (36 cases). Rountree discusses diaphysectomy for chronic osteomyelitis of the fibula. He does not advocate the procedure for osteomyelitis of other long bones nor does he recommend the procedure for osteomyelitis of the fibula in the acute stage. There is a detailed account of his operative procedure and the use of a long rubber drain which is laid in the bed of the resected fibula, with the periosteum closed over it. The drain protrudes from the lower pole of the incision and is gradually removed over a period of ten days to two weeks. The results in 31 patients with a follow-up of from nine months to eight years were as follows: Concerning growth changes, no deformity of the knee or ankle developed. Regeneration of the fibula was complete in 13 cases, incomplete in 8 cases, slight in 3 cases and absent in 7 cases (4 of the

639. Arden, F., and Derrick, E. H.: Osteomyelitis of Odontoid Process of Axis: Case, M. J. Australia **2**:487-488 (Nov. 4) 1944.

640. Neuhof, H., and Arnheim, E. E.: Acute Retroperitoneal Abcess and Phlegmon: Study of Sixty-Five Cases, Ann. Surg. **119**:741-758 (May) 1944.

641. Raventós Moragas, A.: Primary Osteomyelitis of Patella: Case, Rev. clín. españ. **12**:316-320 (March 15) 1944.

642. Rountree, C. R.: Diaphysectomy for Chronic Osteomyelitis of the Fibula, Clinics **2**:1040-1054 (Dec.) 1943.

7 patients were adults). Functional results were satisfactory in all but 3 patients, and these showed some improvement. One case was complicated by pyarthrosis of the ankle. In no instance had there been a recurrence of the osteomyelitis. [ED. NOTE (L. D. B.).—This is an excellent paper.]

The 1944 literature contained four papers that were available for review which discussed infections in bones other than tuberculosis or staphylococcic infections.

Lubert[643] discusses actinomycosis infection of the vertebrae and reports 3 cases, with autopsy and roentgenologic findings. He points out that poor oral hygiene, dental extractions or tonsillectomies may be followed by such infection. He is of the opinion that the vertebrae are involved secondarily, usually by direct extension or occasionally by infection of the blood stream. The disease process is a chronic granuloma, and roentgenograms usually show areas of destruction in all portions of the vertebrae, including the spinous processes and lamina as well as the bodies, with varying amounts of surrounding sclerosis, without roentgenologic evidence of destruction of intervertebral disks. In contradistinction to tuberculosis, collapse of a vertebra despite extensive destruction is unusual.

Colonna and Gucker[644] report a case of blastomycosis of the bone and summarize 67 recorded cases from the literature. In the 67 recorded cases the skeletal lesions were almost commonly found in the following locations in the order given: (*a*) vertebrae, (*b*) skull, (*c*) ribs, (*d*) tibia, (*e*) tarsus, (*f*) knee, (*g*) metatarsus and (*h*) carpus. Infections are usually found in patients with generalized blastomycosis. The mortality rate in cases of skeletal blastomycosis is 89 per cent, only 7 recoveries being reported in the 67 recorded cases. Diagnosis is made by isolation and identification of the fungus. Tentative diagnosis can be made by complement fixation test and skin test. Roentgenograms of the chest may be indicative. The roentgenologic appearance is not pathognomonic; however, definite observations are important. The lesion usually has a patchy appearance, with local destruction and a homogenous periosteal sheath. Treatment recorded in the literature includes a high caloric, high vitamin diet; heliotherapy; blastomyces vaccine; immune serum; neoarsphenamine; antimony; potassium tartrate and potassium iodide. All 7 patients reported as having survived had received a saturated solution of potassium iodide orally. Local treatment has consisted in irrigations and the use of maggots. In the

643. Lubert, M.: Actinomycosis of the Vertebrae, Am. J. Roentgenol. **51**: 669-676 (June) 1944.

644. Colonna, P. C., and Gucker, T., III: Blastomycosis of Skeletal System: Summary of Sixty-Seven Recorded Cases and Case Report, J. Bone & Joint Surg. **26**:322-328 (April) 1944.

case reported, sulfadiazine was used along with potassium iodide, blood transfusions and good supportive care. The patient died four months after his admission to the hospital. Permission for autopsy was not obtained. The areas involved were as follows: knees, elbows, humeri and carpal bones. [ED. NOTE.—It has been my privilege to observe the work of Smith, Martin, Jones and Conant, whose papers are included in Colonna's and Gucker's bibliography. It is the opinion of these workers that in the treatment of blastomycosis infections it is most important that the patient be desensitized before operation is attempted or before treatment with potassium iodide is instituted. They feel that this desensitization will prevent reactions and will help control flare-ups of the infection.]

Chuinard,[645] in an article not available for review, discusses the orthopedic aspects of brucellosis.

Brown and Gottdiener[646] report a case of a white man, aged 21, seen in consultation in regard to a painful shoulder of twelve hours' duration. Examination showed tenderness about the right shoulder. Twleve hours after admission the patient became stuporous and the temperature rose to 102 F. The white blood cell count was 26,700. Lumbar puncture showed 15,000 cells per cubic centimeter, of which 98 per cent were polymorphonuclear cells. A smear revealed gram-negative intracellular and extracellular diplococci. A culture grew out type 1 meningococci. The patient was treated with sulfadiazine and improvement was progressive; the petechial rash over the body disappeared, but rash over both tibias coalesced into a large hemorrhagic area, which was tender. This area of discoloration disappeared slowly over a period of three weeks, but the tenderness remained over the tibias. Roentgenograms of the tibias eighteen days after the patients' admission to the hospital showed irregular cortex, with rarefaction and spotty periosteal elevation. Roentgenograms three months later showed a normal condition except for slight thickening of the anterior cortices. The authors were of the opinion that the changes shown in the tibias were those of localized confluent hemorrhage into the skin and subcutaneous tissues, depriving the periosteum of blood supply, thus diminishing the nutrition of the cortex below.

Pierson and Roach[647] discuss the roentgenologic changes seen with acute hemorrhagic osteomyelitis and point out the pathologic basis for the roentgenologic changes.

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645. Chuinard, E. G.: Orthopaedic Aspects of Brucellosis, Northwest Med. **43**:279-283 (Oct.) 1944.

646. Brown, M. G., and Gottdiener, E. E.: Osteoperiostitis Following Meningococcus Meningitis: Case Report, Mil. Surgeon **94**:270-271 (May) 1944.

647. Pierson, J. W., and Roach, J. F.: Roentgenology of Osteomyelitis, J. A. M. A. **126**:884-886 (Dec. 2) 1944.

Silver and Rushbridge [648] report the use of a saturated iodoform-benzoin solution to counteract the odor of plaster-encased war wounds. The mixture consists of 3 cc. of iodoform and 240 cc. of tincture of benzoin compound, painted over the exterior of the offending area of the cast. The authors state that the solution is readily absorbed by the cast and that the resulting odor is relatively agreeable.

Regan and Henderson [649] report the use of wool impregnated with activated charcoal to counteract odors from plaster-encased wounds, the wool being in the form of a bag. The bag is drawn over the plaster cast. Another method of using the material is in the form of small wool dressings impregnated with the charcoal, which are placed directly over the wound dressing through a cast window. The authors report satisfactory elimination of offensive odors with this method. They refer to the work of Seddon and Florey.

Lambert and Stickney [650] report the use of plaster bandages containing selected activated carbon in an attempt to minimize the odor of plaster in the case of osteomyelitis. This type of plaster roll is now on the market.

XIX. Fracture Deformities

PREPARED BY EUGENE M. REGEN, M.D., NASHVILLE, TENN.; PAUL HARMON, M.D., HUNTINGTON, W. VA., AND GLENN BARBER, M.D., CLEVELAND

FEWER papers were published on fracture deformities in 1944 than in any year since this section of the progress in orthopedic surgery has been written.

Murray [651] has summarized, in outline form, the essentials for success in bone grafting in ununited compound fractures. In order to obtain a "take" of a bone graft in compound fractures, (1) the graft must unite and become an integral portion of the host bone, (2) new bone must form in response to function demands, (3) length and alinement must be preserved during the period preceding grafting or restored at the time of grafting and maintained postoperatively and (4) both active and potential infection must be controlled. Murray discusses the mechanism of new bone formation and the known facts concerning its source as applied to a bed which has been previously infected. It is Murray's opinion that the type of graft is frequently not so important as is the

648. Silver, C. M., and Rushbridge, H. W.: Use of Saturated Iodoform-Benzoin Solution to Counteract the Odor of Plaster-Encased War Wounds: Case, Mil. Surgeon **95**:233 (Sept.) 1944.

649. Regan, J. M., and Henderson, M. S.: Charcoal Wool Filter Cloth as Deodorant, Proc. Staff Meet., Mayo Clin. **19**:268-270 (May 31) 1944.

650. Lambert, C. N., and Stickney, D. W.: New Deodorizing Plaster Bandage, J. Bone & Joint Surg. **26**:836-837 (Oct.) 1944.

651. Murray, C. R.: Basic Problems in Bone Grafting for Ununited Compound Fractures, J. Bone & Joint Surg. **26**:437-442 (July) 1944.

proper preparation of the field to receive the graft and the host's tissues to maintain it. Specifically, these conditions are met by the following steps, which may be indicated prior to operation: (1) systemic attack on infection by attention to anemia, nutrition and systemic use of chemotherapy; (2) local attack on active infection by drainage, removal of dead bone and other foreign bodies and local chemotherapy, (3) allowing of sufficient time to elapse between control of infection and complete healing of the wound prior to bone grafting, (4) continued attention to the systemic status of the patient by estimation of hemoglobin and serum proteins and maintenance of nutrition, including vitamins, (5) utilization of plastic procedures after control of infection and prior to bone grafting, in order to supply a covering of healthy skin and subcutaneous tissues and (6) improvement of the efficiency of the local circulation, by exercise and active use, physical therapy, pressure dressings and supports, positional exercises (for example, Buerger exercises) and use of the extremity against gravity. The use of an extremity suitably braced is the most valuable single procedure to fulfil the latter need.

At operation the following basic steps must be taken: (1) removal of scar tissue from between and about the bone fragments and drilling or resection of sclerotic dense bone down to healthy bone, (2) plastic operations on the soft parts, (3) placing of a graft of adequate size in a bed where it can be most easily vascularized by newly formed connective tissue and (4) rigid fixation of the graft and the fracture fragments. The details of rigid fixation are unimportant, providing the condition is secured. The methods of rigid fixation are internal fixation of the graft, external fixation by plaster, pin and plaster, pin and apparatus or combinations of internal and external fixations. Local and systemic care must be continued in the convalescence.

Goff [652] reports the use of os purum, a substitute for the autogenous implant, in eighty bone-grafting operations performed on 61 patients.

The material was used for spinal fusion in 28 cases, as a peg for fixation in cancellous bone in 9 cases, as a posterior bone for foot drop in 10 cases, as a graft fixation after osteotomy in 8 cases, as a shelf for congenital dislocation of the hip in 7 cases and for obliteration of cranial defects in 2 cases.

In 9 of the 80 instances of operative procedure, the os purum implant had to be partially or entirely removed, for various reasons. Complications occurred in 16 instances, being attributed directly to the os purum implant in 6.

Goff states that all complications totaled 20 per cent, with none constituting a major factor in the end result. Nevertheless, he stated the

652. Goff, C. W.: The Os Purum Implant: A Substitute for the Autogenous Implant, J. Bone & Joint Surg. **26**:758-767 (Oct.) 1944.

belief that the use of os purum has its place and constitutes a satisfactory material for the orthopedic surgeon.

The only inkling the author affords the reader relative to the composition of os purum is given in two or three sentences at the end of the article. Here it is stated that for the duration of the war it appears that os purum cannot be obtained from Sweden, that the supply in this country is nearly exhausted and that perhaps some biochemical manufacturer may see fit to procure os purum in this country, if this can be done under trade agreements.

In a memorandum on the healing of war fractures prepared by the subcommittee of the M. R. C. War Wounds Committee,[653] it is noted that, while delayed union is by no means uncommon, nonunion is comparatively rare, and it should even be rarer except in cases in which there has been gross loss of bone. Nonunion is generally avoidable if reasonable apposition of fragments is secured and uninterrupted immobilization is maintained sufficiently long.

It is noted that of the possible causes of delayed union some are subject to the control of the surgeon while others are not. Of the latter, three causes are listed. The causes controllable—to a greater or lesser extent—by the surgeon are more numerous and of greater importance. Ten are given, and each is discussed under a subheading.

LeCocq and Gilman [654] state the belief that ununited fracture of the clavicle is more common than is generally supposed. They encountered 4 cases during eighteen months of service in naval hospitals. They report a single case, in which there was considerable overriding and deformity. The patient was treated by open operation, exuberant callus and fibrous tissue being removed and the ends of the bones drilled. Good fixation and stability of the fracture were then obtained with a four-holed vitallium plate. Immobilization was in a Sayre type of dressing of muslin for twelve days and then intermittently in a sling. Union was present in six weeks, and the patient had a full functional recovery, with no disability at the shoulder. [ED. NOTE (E. M. R.).—It should be noted that this was an instance of nonunion of only a few months' duration, and it is probable that in established nonunion with loss of bone of years' duration this simple method with relatively little postoperative immobilization would not be successful.]

Rothberg [655] reported a case of fracture of the greater tuberosity of the humerus, with minimal displacement of the tuberosity fragment and

653. The Causes and Prevention of Delayed Union of Fractures, (Sub-Committee on Healing of War Fractures, of M. R. C. War Wounds Committee), Bull. War Med. **4**:559-561 (June) 1944.

654. LeCocq, E. A., and Gilman, P. K., Jr.: Ununited Fracture of Clavicle: Report of Case, U. S. Nav. M. Bull. **42**:1166-1167 (May) 1944.

655. Rothberg, A. S.: Post-traumatic Defect of the Humeral Head, Am. J. Surg. **65**:293-294 (Aug.) 1944.

without dislocation of the humeral head, treated for three weeks by retentive dressings, followed subsequently by active and passive motion. The patient continued to complain of pain in the shoulder, although he continued to gain motion. A roentgenogram made three and one-half months after the injury showed a V-shaped area of bone absorption in the region of the greater tuberosity. Further treatment was by physical therapy and sling for one additional month. At six and one-half months, the patient had a complete range of painless motion (apparently no roentgenogram was made at this time). The author arrived at no definite conclusion as to the cause of the absorption. He compared this defect with the "groove defect," which is seen with regularity and which is part of the pathologic process in recurrent dislocation of the shoulder.

Mandl [656] reports 2 cases of comminuted fracture of the elbow, seen late, at a time when there was ankylosis of the joint proper but a pseudarthrosis in the lower third of the humerus, 2 inches (5 cm.) above the joint. A nearthrosis was produced from the pseudarthrosis by smoothing off projecting osseous spicules and inserting fascia lata about the end of the humerus. In the 2 cases motion, both active and passive, increased from a few degrees to 100 degrees in one case and to 60 degrees in the other, as evaluated three years and one year respectively after surgical attack. One patient worked successfully as a police officer and the other as a blacksmith. Neither complained of pain. Slight instability in lateral planes was present in extension with muscles relaxed. [ED. NOTE.—Roentgenographic reproductions accompanying the article showed progressive sclerosis of the bone ends with increased use. Judging from the descriptions and photographs in the article, the function of such a joint resembles that of an elbow that has been subjected to resection.]

Hamada [657] reports a case of nonunion of a fracture of the lower end of the radius, an exceedingly rare condition. He quotes Watson-Jones as having found but 1 case of nonunion of this fracture out of 3,199 cases of Colles' fracture. The case reported demonstrated shortening of the forearm and pronounced radial deviation of the hand. Hamada treated his patient by a full thickness, onlay, extra-articular graft. Illustrations accompanying the article showed the appearance of the wrist in roentgenograms over a four year period, the latest being the end result. As an intermediate step, the extra-articular bridge of bone extending from the carpal region to the dorsum of the third metacarpal was removed (six months after the first operation). Four years after

656. Mandl, F.: Nearthrosis Following Comminuted Fracture of Elbow Joint, J. Internat. Coll. Surgeons **7**:362-364 (Sept.-Oct.) 1944.

657. Hamada, G.: Extra-Articular Graft for Nonunion in Colles's Fracture, J. Bone & Joint Surg. **26**:833-835 (Oct.) 1944.

operation, the patient had 40 degrees of flexion and 35 degrees of extension, with a good grip but incomplete flexion of the fingers. The roentgenogram showed that the onlay graft had consolidated into a fairly wide but distorted distal radius. Union had occurred with the distal fragment. There was a fairly large dorsal projection of the graft over the proximal carpus, but this configuration appeared to be essential for the stability of the wrist. This is a good example of utilization of a graft for temporary fixation for alinement of the carpus and metacarpus as well as the proximal radial fragment and the ununited fragment, the carpus and metacarpals later being freed by excision of the distal portion of the graft.

Velasco and Cal [658] reported studies of 113 cases of fracture of the carpal scaphoid, with patients in 79 cases treated by the authors. The cause of pseudarthrosis of the carpal scaphoid is discussed. Pseudarthrosis developed in 16 per cent of their recent cases and in 42 per cent of their older cases. They recommend conservative treatment in recent cases. If roentgenologic examination at the end of three months does not show bony union but does indicate that healing is progressing, another six months of conservative treatment may be tried. If after three months of conservative treatment by immobilization the roentgenograms fail to show any signs of bony repair, bone grafting is indicated. In older patients with pseudarthrosis but no serious arthritis bone grafts may be used with good results. If pseudarthrosis is not complete, prolonged immobilization may promote bony union if immobilization has not been tried before. If immobilization has been tried, immediate grafting is indicated. Beck drilling failed in the authors' hands. In the cases of fracture with pronounced displacement and irreducibility, excision is indicated.

Burns and Michaelis [659] report 26 cases in which a sliding bone graft was used for ununited fracture of the tibia. The grafts were fixed in position with vitallium screws. They report but one failure in their series.

In their report the statement is made that "In none of our patients was the fibula ununited, and when it was keeping the ends apart, it was either fractured or divided so as to allow the necessary contact to be made (8 cases)."

[ED. NOTE (E. M. R.).—The last statement is of interest because there have appeared in the recent literature two articles which were primarily concerned with the influence of an intact or early united fibula as a cause of nonunion in the tibia.]

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658. Velasco, R. N., and Cal, G.: Pseudarthrosis of Carpal Scaphoid Bone: Prevention and Therapy, Bol. y trab., Soc. argent. de cirujanos **4**:777-790, 1943.

659. Burns, B. H., and Michaelis, L. S.: Sliding Graft for Ununited Fractures of the Tibia, Lancet **1**:337-338 (March 11) 1944.

Albert [660] reviewed 395 cases of fracture of the tibia and fibula in adults, to see whether some of the views recently put forward concerning the cause of delayed union in these fractures could be sustained.

The time and stage or degree of union were given on clinical grounds or proved roentgenographic consolidation. On this basis the time of clinical union (in weeks) is plotted against the number of cases in twenty-three graphs illustrating the various factors considered in the analysis. Twenty weeks was taken as the dividing line between normal and delayed union. On this assumption union in 282 cases, or 71 per cent, was normal and in 113 cases, or 29 per cent, delayed.

The important conclusions expressed by the author as a result of his analysis are:

1. There has been an increase in the incidence of delayed union during this war.
2. This is noticed mainly in the newly established clinics.
3. The increase is noticed in both simple and compound fractures.
4. In the greater number of compound fractures, "disturbance" of the course of treatment and the use of continuous skeletal traction appear to be the chief factors causing this increase.

Truog [661] reported 7 cases in which "ring" sequestrums developed in the tibia after the use of Steinman pins (6 cases) and Kirschner wires (1 case) as fixed traction for fractures. The pins and wires were incorporated in plaster. A positive culture for Staphylococcus aureus was obtained in 1 case, and there was copious discharge in the others (no mention was made of bacterial cultures in the other 6 cases). In 5 of the 7 cases sequestrectomy was performed, following which there was more or less prompt healing. Two of the patients did not have sequestrectomy performed and still had draining sinuses at the time the paper was written. The author recommended that skeletal traction be removed as soon as roentgenograms show "ring" sequestrum. Subsequent treatment should be sequestrectomy. Truog's opinion was that the causation was probably pressure necrosis plus a low grade infection. The possibility that these lesions might be the products of thermal necrosis produced by too rapid and vigorous insertion of the pins was not mentioned.

A brief history of bone drilling to promote osteogenesis in nonunion and delayed union of fractures is given by Pusitz and Davis.[662]

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660. Albert, M.: Delayed Union in Fractures of Tibia and Fibula, J. Bone & Joint Surg. **26**:566-578 (July) 1944.

661. Truog, C. P.: "Ring" Sequestra as Complication of Fixed Skeletal Traction, Am. J. Roentgenol. **52**:64-69 (July) 1944.

662. Pusitz, M. E., and Davis, E. V.: Bone-Drilling in Delayed Union of Fractures, J. Bone & Joint Surg. **26**:560-565 (July) 1944.

They state that bone drilling is not a method of choice in the treatment of definite nonunion. They enumerate three essential types of nonunion, namely, (1) typical pseudarthrosis, with sclerosis of the ends of the fragments, (2) fibrinous union with osteoporosis of the fragments and (3) fibrinous union with atrophy of disuse. They point out that although there may be no discernible callus in delayed union there is no sclerosis of the ends of the fragments. Delayed union should be considered to be present if there is no evidence of callus formation at the end of four to six months.

The technic used by the authors is described, and an analysis of 25 consecutive cases in which the method was used are reported. In all cases except 1 bony union developed both clinically and roentgenologically. The average duration for the development of union after drilling was eight weeks; the shortest period of time was three weeks, and the longest was five months. The patients were permitted to be up and walking in casts a week or ten days after operation.

Farill [663] describes the technic for a fibular transplant in destruction of the tibial diaphysis by osteomyelitis. He reports 2 cases in which fibula transplants were used from the normal leg. Multiple transverse perforations were placed in the grafts to facilitate nutrition and to hold it in contact with the tibial fragments. The author feels that his technic conserves the line of the fibula of the affected leg and does not endanger the chief supporting bone of the normal leg. The graft is taken from the upper two thirds of the normal fibula.

Nunziata [664] presents the technic of subastragalar arthrodesis in old fractures of the os calcis. He reviews the various technics for treating fractures of the os calcis and states that if union is not satisfactory arthrodesis is indicated. After the arthrodesis and the postoperative convalescence of one week, a walking cast is applied and the patient is allowed to be up and about. The cast is removed after four months.

XX. Conditions Involving the Lower Part of the Back

PREPARED BY R. BEVERLY RANEY, M.D., DURHAM, N. C.

THE year 1944 has seen no spectacular advances toward solution of the many problems of pain in the lower part of the back and sciatic pain. The considerable volume of literature on this subject demonstrates widespread interest; a gradual evolution of certain trends

663. Farill, J.: Fibular Graft in Treatment of Destruction of Tibial Diaphysis: Technique of Operation, Gac. méd. de México **74**:392-399 (Aug. 31) 1944.

664. Nunziata, A.: Old Fractures of Calcaneum; Subastragalar Arthrodesis, Prensa méd. argent. **31**:1881-1883 (Sept. 20) 1944.

of orthopedic thought becomes apparent. There is a healthy tendency to emphasize the basic lesion rather than the symptom of sciatica. Most writing and most controversy still center about the syndrome of the ruptured intervertebral disk and its treatment. Studies of the end results of operations on disks are beginning to appear and should be most helpful; these first statistical reports are not too encouraging. The role of bony changes, such as facet irregularities and isthmus defects, is receiving increased recognition.

Because of the volume of this literature, only the more outstanding articles are reviewed here. For the sake of completeness, however, others are mentioned in proper context and listed in the references.

Pain in the Lower Part of the Back.—Many reviews and summaries [665] of the problem of pain in the lower part of the back appeared in the literature during 1944. In most of these sciatica is discussed as a secondary feature. While adding little to recorded knowledge of the subject, these articles serve a practical purpose in presenting various aspects of the problem in proper perspective and in disseminating current orthopedic opinion to all groups of physicians. Outstanding among general summaries during the year are the papers of Ghormley, Billington and Knight. Yaskin and Finkelstein review in comprehensive fashion the various types of cases characterized by pain in the lower part of the back and sciatic pain. Carey presents a readable summary of essential anatomic and physiologic considerations relating to the normal spine and considered prerequisite to an understanding of

665. Axford, M.: Industrial Back with Some Observations on Compensation Aspect, New Zealand M. J., April 1943, supp., pp. 24-28. Fuldner, R. V.: Diagnosis of Minor Back Disabilities, Mil. Surgeon **95**:228-232 (Sept.) 1944. Carey, E. J.: Anatomical and Physiologic Considerations Prerequisite to Diagnosis of Back Trauma, Radiology **41**:554-559 (Dec.) 1943. Billington, R. W.: Causes of Low Back Pain and Sciatica, J. Tennessee M. A. **37**:113-116 (April) 1944. Burt, H.: Low Back Pain: Its Prevention and Treatment, Brit. J. Phys. Med. **7**:11-17 (Jan.-Feb.) 1944. Ghormley, R. K.: Backache: Examination and Differential Diagnosis, J. A. M. A. **125**:412-416 (June 10) 1944. Knight, R. A.: Disability Due to Low Back Pain, Memphis M. J. **19**:84-87 (June) 1944. Krida, A.: Symposium on Orthopedic Surgery: Backache and Sciatica, Clinics **2**:1055-1066 (Dec.) 1943. Magnuson, P. B.: Diagnosis of Low Back Pain, Proc. Interst. Postgrad. M. A. North America (1943), 1944, pp. 164-167. McFetridge, S. A.: Brief Summary of Back Pain and Interpretation of Orthopaedic Specialists' Reports, Bull. Vancouver M. A. **20**:81-83 (Dec.) 1943. Morris, S.: Low Back Pain—Anatomy and Physiology, New Zealand M. J., April 1943, supp., pp. 28-31. Stucky, E. K.: Diagnosis and Treatment of Low Back Pain, Arch. Phys. Therapy **25**:34-40 (Jan.) 1944. Haggart, G. E.: Clinical Observations on Low Back and Sciatic Pain, with Particular Reference to Lumbosacral Joint and to Intervertebral Disk Syndrome, S. Clin. North America **24**:723-730 (June) 1944. Yaskin, J. C., and Finkelstein, A.: Low Back and Leg Pains: Some Clinical Considerations, Clinics **3**:261-308 (Aug.) 1944.

the diagnosis of injury of the back. Fuldner reviews for medical officers the essential points in the diagnosis of minor disabilities of the back. Axford discusses the compensation aspects of injuries of the back in industry.

Neurologic aspects of pain in the lower part of the back are discussed by Turner.[666] He points out that pain in the back may be attributed to involvement of either the peripheral nerves or the dorsal roots. He considers that neuritis or neuropathy of the nerves of the trunk is rare and that involvement of the spinal roots is the usual mechanism of pain in the back. The cause of this involvement may be an infectious process in the meningeal envelopes or in the roots themselves or a mechanical process which stretches or compresses the roots. In such radiculitis, motor as well as sensory roots may be involved. Turner discusses the pathogenesis and manifestations of radiculitis in a number of common disease entities characterized by pain in the lower part of the back.

In a provocative article, Dandy[667] states his belief that recurring attacks of backache in the low lumbar region, without sciatica, have precisely the same underlying cause as backache plus sciatica, i. e., defective intervertebral disks. He reports 20 cases in which there were large protruding disks compressing the nerves despite the fact that sciatica had never been present. He makes his diagnosis from history, neurologic examination (frequently negative) and roentgen examination of the vertebrae, stating the belief that pathognomonic evidence of defective disks is present in more than half of the cases. At operation he locates the defective disk by testing the mobility of the vertebrae. Dandy expressed the opinion that defective disks are multiple in 80 per cent of the cases, that spinal injections of any type should be condemned, that complete removal of the disk produces spinal fusion and that spinal arthrodesis of the usual orthopedic type is never necessary. He states that persistence or return of backache or sciatica is explained by failure to identify the defective disk, incomplete removal of the disk or the presence of a tumor. [ED. NOTE (R. B. R.).—Several of these conclusions are contrary to orthopedic experience and for acceptance would require much more confirmatory data than is now available.]

The important role of abnormalities of the articular facets in the causation of pain in the lower part of the back has received detailed

666. Turner, C. C.: Neurologic Origin of Back Pain, Memphis M. J. **19**:82-84 (June) 1944.

667. Dandy, W. E.: Treatment of Recurring Attacks of Low Backache Without Sciatica, J. A. M. A. **126**:1175-1178 (Aug. 26) 1944.

attention in only two articles. Wright [668] discusses the part played by the facets in the mechanics of locomotion. Scott,[669] reviewing the records of a large naval air center for the first fifteen months of the war, emphasizes the importance of subluxations of the apophysial joints and of the less common fractures of the articular facets. He considers oblique roentgenograms to be of great value and describes his technic for making them. Roentgenologic diagnosis of subluxations of the apophysial joints is based on the following findings: narrowing of the intervertebral disk space, excessive overriding of the articular surfaces of opposing facets and erosion and sclerosis from impingement of the superior articular facet of the lower vertebra on the pedicle of the vertebra above and of the opposing facet on the lamina of the vertebra below. For patients with apophysial subluxations and sciatic pain, he advises spinal myelography to determine the presence of an intraspinal protrusion of the disk. If this is found to be present, both lesions should be treated surgically.

Clinical interest in the ill defined syndrome of fibrositis appears to be declining. Fat herniations in cases of pain in the lower part of the back are described by Copeman and Ackerman.[670]

A timely presentation of cases of primary lesions of the gastrointestinal tract with pain referred to the back is made by Rivers and Roodenburg.[671] They discuss the mechanism of referred pain and describe its typical distribution in each of the common diseases of the gastrointestinal and accessory gastrointestinal tracts. Intensification of the pain in the back is thought to indicate a progression of the gastrointestinal lesion. Reports of several illustrative cases are presented. Rivers and Roodenburg do not include references to possible orthopedic and neurologic findings such as deformity, spasm, tenderness and sensory changes. The association of pain in the lower part of the back with endocrine disorders is discussed by Hutton.[672]

There is continued interest in elucidating the physiology and pathologic changes of the lumbosacral junction by means of improved

668. Wright, J.: Mechanics in Relation to Derangement of Facet Joints of Spine, Arch. Phys. Therapy **25**:201-206 (April) 1944.

669. Scott, W. G.: Low Back Pain: Subluxations of Apophyseal Joints and Fractures of Articular Facets, U. S. Nav. M. Bull. **43**:234-240 (Aug.) 1944.

670. Copeman, W. S. C., and Ackerman, W. L.: "Fibrositis" of Back, Quart. J. Med. **13**:37-51 (April-July) 1944.

671. Rivers, A. B., and Roodenburg, A. I.: Back Pain in Disease of Gastrointestinal and Accessory Gastrointestinal Tract, J. A. M. A. **125**:421-426 (June 10) 1944.

672. Hutton, J. H.: Endocrine Disorders and Low Back Pain, Indust. Med. **13**:241-243 (March) 1944.

roentgenographic technic and interpretation. Brailsford [673] and Cornwell [674] have written on this subject. Gianturco [675] has carried out, by means of roentgenograms, a detailed analysis of the mechanics of flexion and extension of the lower lumbar vertebrae in normal persons and in persons suffering from pain in the lower part of the back. Breck, Hillsman and Basom [676] studied lumbosacral roentgenograms of 450 consecutive male applicants for work in a heavy industry. The detailed roentgenographic findings were tabulated. No instance of tuberculosis, osteomyelitis or postoperative fusion was encountered. In 31 per cent there were significant pathologic changes, however, and in 15 per cent these were considered severe enough to necessitate a refusal of employment. The authors conclude that roentgenographic examination of the lumbosacral portion of the spine is of great value as a preliminary to employment in heavy labor. The statistics are of particular interest in view of the fact that all the subjects denied having or having had pain in the lower part of the back.

Individual methods of treating certain types of pain in the lower part of the back are described in several brief articles. Argo [677] was successful in relieving pain ascribed to ligamentous sprain by injecting procaine hydrochloride locally. Turner [678] discusses the treatment of backache by manipulation, and Rankine [679] describes therapeutic exercise. Isaev [680] has written on the treatment of pain in the lower part of the back and sciatica with electrical currents of ultra high frequency.

Sciatica.—In many articles reference is made to pain in the lower part of the back, but chief emphasis is placed on the problem of sciatic pain.

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673. Brailsford, J. F.: Value of Radiography in Lumbosacral Lesions, M. Press **212**:315-319 (Nov. 15) 1944.

674. Cornwell, W. S.: Lumbosacral Junction, Radiog. & Clin. Photog. (no. 1) **20**:2-11, 1944.

675. Gianturco, C.: Analysis of Motion of Lower Lumbar Vertebrae in Normal Individuals and in Patients with Low Back Pain, Am. J. Roentgenol. **52**:261-268 (Sept.) 1944.

676. Breck, L. W.; Hillsman, J. W., and Basom, W. C.: Lumbosacral Roentgenograms of Four Hundred and Fifty Consecutive Applicants for Heavy Work, Ann. Surg. **120**:88-93 (July) 1944.

677. Argo, W. L.: Novocain Injection for Low Back Strain, Hawaii M. J. **3**:133-134 (Jan.-Feb.) 1944.

678. Turner, J. M.: Value of Manipulative Surgery in Treatment of Low Back Pain, M. Press **212**:202-204 (Sept. 27) 1944.

679. Rankine, T. G.: Remedial Exercise for Backache, J. Roy. Army M. Corps **81**:250-251 (Nov.) 1943.

680. Isaev, V. V.: Ultra-High Frequency Currents in Therapy of Lumboischialgic Syndrome, Nevropat. i psikhiat. (no. 4) **11**:91, 1942.

In a brief and interesting presentation Jackson [681] analyzed 100 cases of chronic sciatic pain—mostly from British military services—from the standpoints of etiology and of differential diagnosis. In 21 cases the exact cause remained doubtful despite extensive study. In 20 cases sciatica was ascribed to fibrositis, in 18 to ruptured intervertebral disks and in 10 to hysteria. Jackson feels that the influence of neurosis in cases of sciatica has been understressed. Hysteria alone is responsible in some cases and is a secondary and complicating factor in many others. From a detailed tabulation of the symptoms and signs in the entire group of 100 cases, Jackson draws a primary conclusion that there is complete absence of a single clearcut diagnostic syndrome; the majority of the symptoms and signs may occur in any etiologic group. Jackson considers Lasegue's test of no value in diagnosis, though useful in evaluating the severity and progress of sciatica. He concludes that ruptured intervertebral disks, fibrositis and neurosis are the three factors of greatest importance in the causation of chronic sciatica in young persons; they correspond with the three types of sciatic pain, viz., neural, referred and functional, into one of which groups each case of sciatic pain should be placed as a preliminary diagnostic step.

Le Vay [682] presents a study of 40 cases of sciatica in military personnel, with particular emphasis on details of the history and physical examination. He concludes that most cases of sciatica are due to lesions of the intervertebral disks. No evidence suggested that any of the patients were suffering from sciatic neuritis, and the author states that it is difficult to see why this diagnosis should still be made for a group of clinical features shown to be due so often to a proved lesion.

In a contrasting article, Magnuson [683] discusses the etiology and pathogenesis of pain in the lower part of the back accompanied by sciatic pain. He points out the frequency of pathologic changes in the lumbosacral joints and discusses their importance as a cause of pressure on the nerve roots and sciatica. Anatomic details are shown in photographs of dissected spines. Reasoning on these data, Magnuson states the belief that "promiscuous operation for and removal of intervertebral disks without definite evidence of root pressure is not justifiable until every other method of treatment has been reasonably tried." He advocates permanent immobilization of the spine at the time of operation for a ruptured nucleus pulposus.

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681. Jackson, W. P. U.: Differential Diagnosis of Chronic Sciatic Pain: Note, with Short Analysis of One Hundred Recent Cases, Brit. M. J. **2**:776-778 (Dec. 18) 1943.

682. Le Vay, A. D.: Sciatica: Study of Forty Cases, Lancet **1**:116-118 (Jan. 22) 1944.

683. Magnuson, P. B.: Differential Diagnosis of Causes of Pain in Lower Back Accompanied by Sciatic Pain, Tr. South. S. A. (1943) **55**:345-358, 1944.

Articles on sciatica written in 1944 include also those of Forestier [684] in French, and of Müller [685] and of Vaubel,[686] in German. The role of tumors of the caudal medulla and cauda equina in causing sciatica, as well as their surgical therapy, are pointed out in two articles from South America—those of Diez [687] and Estévez.[688]

The year has produced several laboratory studies of the causes of sciatica. Larmon [689] dissected ten spines obtained at necropsy, observing the relative size of nerve roots and foramens, the effect on the roots of variations in contiguous ligamentous and osseous structures and the effects of swelling of the joint capsules produced by the injection of oil. Such injection produced sufficient swelling of the capsular ligamentum flavum to compress the spinal nerves in the foramens. Other factors found to produce compression of the spinal nerves were posterior lipping of the vertebral bodies, anomalies of the first sacral body, narrowing of the intervertebral foramen due to collapse of the disk and variations in the ligamentous structures adjacent to the fifth lumbar foramen. [Ed. Note (R. B. R.).—This is useful substantiation of some of the postulated causes of sciatic pain; it serves to emphasize the fact that pressure on a nerve root may often be the result of factors other than intraspinal protrusion of an intervertebral disk.] Elliott [690] has carried out electromyographic studies in cases of sciatica. Most of the tender spots in muscles were found to show increased irritability, representing muscle spasm, which Elliott believes causes pain and tenderness and constitutes the essential change in fibrositis or myositis. Brailsford [691] investigated sciatica and lumbago from the radiologic aspect.

Kelman [692] reports his technic and results in the use of epidural injection for sciatic pain from various causes. One hundred and

684. Forestier, J.: Sciatica as Vertebral Disease, Lyon méd. **167**:387-391 (May 17) 1942.

685. Müller, I.: Sciatica as Sequel of Trauma, Ztschr. f. ärztl. Fortbild. **39**: 76-79 (Feb. 15) 1942.

686. Vaubel, E.: Localization of Pain in Sciatic Nerve, Deutsche med. Wchnschr. **69**:49 (Jan. 22) 1943.

687. Diez, J.: Tumors of Cauda Equina Diagnosed and Treated Surgically When Stubborn Sciatica Is Only Symptom: Cases, Rev. Asoc. méd. argent. **57**: 925-929 (Nov. 15) 1943.

688. Estévez, R.: Fibroma of Caudal Medulla with Sciatica: Surgical Therapy of Case, Rev. méd. de Chile **71**:1207-1210 (Dec.) 1943.

689. Larmon, W. A.: Anatomical Study of Lumbosacral Region in Reaction to Low Back Pain and Sciatica, Ann. Surg. **119**:892-896 (June) 1944.

690. Elliott, F. A.: Tender Muscles in Sciatica: Electromyographic Studies, Lancet **1**:47-49 (Jan. 8) 1944.

691. Brailsford, J. F.: Investigation of Sciatica and Lumbago: Radiologic Aspect, Brit. J. Radiol. **17**:308-311 (Oct.) 1944.

692. Kelman, H.: Epidural Injection Therapy for Sciatic Pain, Am. J. Surg. **64**:183-190 (May) 1944.

sixteen patients were treated with a total of four hundred and eighty-six injections. Eight patients were cured of pain, 41 greatly improved, 45 moderately improved, 17 slightly improved and 5 unchanged. [ED. NOTE (R. B. R.).—While epidural injection is at times a useful treatment for the symptom of sciatic pain, rational curative therapy must obviously be directed at the causative lesion. When the causes of sciatica are better understood, mere symptomatic treatment will be less used and the percentage of cures will be greater. Progress along these lines is being made.]

Hurst,[693] in an article subtitled "An Essay in Debunking," reviews a number of methods of treating sciatica, popular at various times since the beginning of the present century. He attributes most, if not all, of their good results to their psychologic value. For the treatment of sciatica he recommends rest in bed in the average case, fixation by means of a plaster spica in the exceptionally severe case, and in all cases psychotherapy in the form of suggestion that the patient is to expect rapid and complete or almost complete recovery. [ED. NOTE (R.B.R.).—Sciatica is only a symptom; diagnostic and therapeutic effort should be directed primarily at its cause.]

Intervertebral Disks.—The ruptured disk continues to be the subject of many clinical studies and reports. A number of excellent reviews of current knowledge of this syndrome are available in the 1944 literature. The groups of cases are large, the clinical features are stated clearly and the articles make good teaching material. Jelsma [694] has analyzed 1,000 consecutive cases of pain in the lower part of the back, in 531 of which the cause was a focal neurologic lesion; of these, 484 were diagnosed herniated disk. Adson's [695] article reviews all important phases of the subject. Poppen [696] summarizes the clinical findings in 200 cases closely observed at the Lahey clinic. A number of articles [697] stress recognized

693. Hurst, A.: Treatment of Sciatica: Essay in Debunking, Brit. M. J. **2**: 773-775 (Dec. 18) 1943.

694. Jelsma, F.: Clinical Analysis of 1,000 Consecutive Cases of Low Back Pain, with Particular Reference to Sciatic Pain Caused by Extrusion of Intervertebral Disk, South. M. J. **37**:372-378 (July) 1944.

695. Adson, A. W.: Diagnosis and Treatment of Protruded or Ruptured Intervertebral Disks as Cause for Low Back Pain and Sciatica, Proc. Interst. Postgrad. M. A. North America (1942), 1943, pp. 196-201.

696. Poppen, J. L.: Management of Ruptured Intervertebral Disks, Proc. Interst. Postgrad. M. A. North America (1943), 1944, pp. 118-120.

697. Gardner, W. J.: Protrusion of Intervertebral Disk: Common Cause of Sciatica, Cleveland Clin. Quart. **11**:66-74 (July) 1944. Wilson, A. A.: Clinical Aspects of Protruded Intervertebral Disk, West Virginia M. J. **40**:107-111 (April) 1944. Taffel, M.: Herniation of Intervertebral Disk and Low Back Pain, New

(Footnote continued on next page)

features of this entity and add little that is new. The structure, functions and lesions of intervertebral disks are discussed by Roberts [698] and by Putschar,[699]

Keegan [700] presents an outstanding analysis of the neurologic diagnosis of herniation of the lumbar intervertebral disks. He has constructed a composite dermatome chart of the lower extremity, determined by hypalgesia from losses of a single nerve root, which should be most useful. His discussion of the neurologic mechanisms involved in the ruptured disk syndrome is enlightening.

Echols [701] discusses the neurologic lesions which cause pain in the lower part of the back and sciatic pain; his review of this group of disorders serves as a useful background on which to project in detail the neurologic picture of the ruptured intervertebral disk. The neurologic diagnosis and differential diagnosis are clearly drawn.

Dandy [702] has stimulated much discussion by presenting several new conceptions of various aspects of the ruptured disk syndrome. He considers that anatomic variations of the lumbar articular facets form an important factor in the causation of defective lumbar intervertebral disks. He expresses the opinion that the sequence of events in pain in the lower part of the back and sciatica is as follows: 1. A sudden severe lift or twist tears the capsule at the lateral articulation and loosens the joint. 2. These loose joints automatically throw an additional strain on the intervertebral cartilages. 3. The result of this sustained trauma is an injured disk, which protrudes and impinges on the emerging spinal nerve. He expresses the opinion that defective lumbar intervertebral disks are nearly always multiple or potentially multiple and that failure to appreciate this is a principal reason for disappointing results from surgical treatment. He states the belief

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Zealand M. J., April 1943, supp., pp. 22-23. Gross, S. W.: Intervertebral Disk Protrusions in Military Practice, Tr. Am. Neurol. A. **69**:119-123, 1943. Oppenheimer, A.: Pathology, Clinical Manifestations and Treatment of Intervertebral Disk Lesions, New England J. Med. **230**:95-105 (Jan. 27) 1944. Peyton, W. T., and Levin, J. D.: Posterior Herniation of Intervertebral Disks: Analysis of Sixty-Five Cases, Minnesota Med. **27**:263-273 (April) 1944.

698. Roberts, F.: Nature and Functions of Intervertebral Disks, Brit. J. Radiol. **17**:54-59 (Feb.) 1944.

699. Putschar, W. G. J.: Pathology of Intervertebral Disks, West Virginia M. J. **40**:101-107 (April) 1944.

700. Keegan, J. J.: Neurosurgical Interpretation of Dermatome Hypalgesia with Herniation of Lumbar Intervertebral Disk, J. Bone & Joint Surg. **26**:238-248 (April) 1944; Diagnosis of Herniation of Lumbar Intervertebral Disks by Neurologic Signs, J. A. M. A. **126**:868-873 (Dec. 2) 1944.

701. Echols, D. H.: Neurologic Aspects of Low Back Pain and Sciatica, J. A. M. A. **125**:416-420 (June 10) 1944.

702. Dandy, W. E.: Newer Aspects of Ruptured Intervertebral Disks, Ann. Surg. **119**:481-484 (April) 1944.

that a reduced interspace in the roentgenogram indicates that a fusion or partial fusion has occurred. He proposes a thorough curettage of the interior of the disk, extraction of its contents and removal of the protruding portion, stating the belief that the result will be fusion of the entire vertebral surfaces. Dandy has treated 15 patients with backache and sciatica, 6 with congenitally defective lumbar vertebrae and 10 with spondylolisthesis by removal of the intervertebral disk to produce vertebral fusion. The results in cases of backache without sciatica were precisely the same as in those with sciatica. Dandy pays a tribute to Goldthwait, who in 1911, eighteen years before protrusion of a disk was first recognized at operation, suggested the possibility of rupture of a disk as a cause of nerve root pain. [ED. NOTE (R. B. R.). —A larger series of observations would be required to establish these beliefs, many of which are at variance with well founded orthopedic opinion.]

French and Payne [703] report on a group of 8 patients who had large protrusions of intervertebral disks compressing the cauda equina. They point out the difficulty of differentiating this type of disk lesion from cauda equina tumor. These patients had pain in the lower part of the back and in both lower extremities, with numbness in the saddle area, both lower extremities or both of these locations; they also had weakness and sphincteric disturbances. A long history of pain in the back followed by an acute episode of rapid progression of the symptoms was typical. The physical findings included weakness or atrophy in the gluteal region or the lower extremities or both, with sensory changes, multiple reflex changes and abnormalities of the sphincters. The spinal fluid protein was increased. Roentgenograms showed narrowing of the lumbosacral interspace, and myelography demonstrated a complete or nearly complete subarachnoid block. The treatment included surgical removal of large nucleus protrusions which were severely compressing the dural sac; in 3 of the cases spinal fusion also was carried out.

Echols [704] reports the case of a 39 year old man who had two ruptured lumbar intervertebral disks, one of which followed the other by two and a half years and appeared to be of nontraumatic origin.

O'Connell [705] discusses maternal obstetric paralysis and reports 4 cases of this paresis of the lower extremities in which ruptured lumbar disks were found. He states the belief that relaxation of the pelvic

703. French, J. D., and Payne, J. T.: Cauda Equina Compression Syndrome with Herniated Nucleus Pulposus: Eight Cases, Ann. Surg. **120**:73-87 (July) 1944.

704. Echols, D. H.: Rupture of Fourth and Fifth Lumbar Disks with Bilateral Sciatic Pain: Case, Texas State J. Med. **39**:477-479 (Jan.) 1944.

705. O'Connell, J. E. A.: Maternal Obstetric Paralysis, Surg., Gynec. & Obst. **79**:374-382 (Oct.) 1944.

joints due to an endocrine factor may facilitate rupture of a disk, particularly in the presence of the abnormal mechanical stresses of pregnancy and labor. For prophylaxis he advises against any type of heavy work during pregnancy. [Ed. Note (R. B. R.).—It is common orthopedic experience to encounter young mothers whose pain in the back began during pregnancy or immediately afterward. So far as this editor knows, statistics on the incidence of lesions of the intervertebral disks in this group of patients are not available. As additional prophylactic treatment for pregnant women in whom backache develops, the use of a maternity corset may be advisable.]

In the diagnosis of lesions of the intervertebral disks, contrast myelography occupies, in the opinion of most observers, an important place. Copleman [706] advocates its use in every case of suspected rupture of an intervertebral disk, for the purpose of demonstrating the level of the protrusion, whether it is single or multiple and whether the defect is due to a lesion of a disk or to a tumor. He uses Pantopaque, aspirating it at the end of the fluoroscopic examination. Copleman favors Pantopaque because of its low viscosity, failure to produce reaction, tendency to remain homogeneous and partial transparency. Lang and Fishback [707] discuss various types of contrast myelography and their localization value. The observations on examination with Pantopaque were verified at operation. The findings on examination of 18 patients with the use of iodized poppyseed oil were also proved correct at operation; of nineteen air myelographies, only one was interpreted inaccurately. The authors conclude that localization by contrast myelography may be 95 per cent correct. [Ed. Note (H. H. K.).—This excellent percentage is not always obtained. In a series of one hundred and forty-four myelographies with iodized poppyseed oil known to me, the diagnosis was proved to be accurate in 82 per cent.] Bradford,[708] discussing the management of ruptured intervertebral disks among naval personnel, advises contrast myelography, advocates Pantopaque and describes the technic in detail. Eaglesham [709] gives the technical details of myelography with iodized poppyseed oil and with Pantopaque (ethyliodophenylundecylate) and discusses the roentgenographic interpretation.

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706. Copleman, B.: Roentgenographic Diagnosis of Small Central Protruded Disk, Including Discussion of Use of Pantopaque as Myelographic Medium, Am. J. Roentgenol. **52**:245-252 (Sept.) 1944.

707. Lang, E. F., and Fishback, H. R., Jr.: Myelography in Diagnosis of Ruptured Intervertebral Disks, Harper Hosp. Bull. **2**:34-38 (April) 1944.

708. Bradford, F. K.: Intervertebral Disk: Problem in the Navy, U. S. Nav. M. Bull. **42**:763-775 (April) 1944.

709. Eaglesham, D. C.: Opaque Myelography of Lumbar Disk Herniations, Brit. J. Radiol. **17**:343-348 (Nov.) 1944.

Sufficient experience with the treatment of patients with ruptured intervertebral disks has now made possible an evaluation of the therapeutic results. A number of articles devoted primarily to analyses of end results are available in the literature of 1944. Grant [710] reports on 150 patients, with a follow-up period of from six months to five years. Seventy-eight patients were cured, 56 improved and 16 unimproved by removal of the disk; spinal fusion was not done. As a result of his experience, Grant states: "No patient suspected of having a ruptured disk is considered for operation unless he has had two or more attacks of pain and unless the pain is severe at the time he presents himself in clinic." Shinners and Hamby [711] found that of 87 patients whose disk protrusions had been removed at least six months before 43 considered themselves cured, 42 considered themselves improved and 2 thought themselves in some way worse than before operation. Fusion was done in only a small percentage of these cases.

Smith, Deery and Hagman [712] present an analysis of 100 patients who had removal of ruptured intervertebral disks. In 70 patients in whom spinal fusion also was done, observation at least one year after operation showed that 24 had excellent results, 33 good and 13 poor. Of 12 patients in whom only removal of the disk was carried out, 5 had excellent results, 5 good and 2 poor. The authors are convinced that in many instances of ruptured disk there is a deranged or unstable lumbosacral joint and that after removal of the disks such backs should be fused. Henry [713] stresses the value and describes the procedures of conservative treatment, advising removal of the disk and spinal fusion only if pain persists despite thorough nonoperative treatment.

Botterell, Keith and Stewart [714] analyzed a group of 51 Canadian soldiers who were explored with the preoperative diagnosis of herniation of a lumbar intervertebral disk. Of these, 29 returned to full duty and 14 to sedentary duty, and 8 were unfit for military service. They

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710. Grant, F. C.: Operative Results in Intervertebral Disks, J. Neurosurg. **1**: 332-337 (Sept.) 1944.

711. Shinners, B. M., and Hamby, W. B.: Results of Surgical Removal of Protruded Lumbar Intervertebral Disks, J. Neurosurg. **1**:117-122 (March) 1944.

712. Smith, A. De F.; Deery, E. M., and Hagman, G. L.: Herniation of Nucleus Pulposus: One Hundred Cases Treated by Operation, J. Bone & Joint Surg. **26**:821-828 (Oct.) 1944.

713. Henry, M. O.: Conservative Treatment of Disk Syndrome, Minnesota Med. **27**:809-811 (Oct.) 1944.

714. Botterell, E. H.; Keith, W. S., and Stewart, O. W.: Results of Surgical Treatment of Sciatica Due to Herniation of Intervertebral Disk in Canadian Soldiers Overseas, Canad. M. A. J. **51**:210-214 (Sept.) 1944.

stress the necessity of careful selection of cases and state that the patient most likely to be returned to full duties possesses these characteristics:

> His age is less than 35 and preferably under 30. He is suffering acutely from sciatica and has had some degree of disability, continuous or recurrent, for three to six months in spite of a variety of treatments. He has no physical defects other than those attributable to sciatica. His army career has been a reasonably happy and successful one. He is not anxious to be discharged from the army on account of domestic difficulties and he is considered emotionally stable apart from the inevitable effects of the pain and restricted activity.

In the French literature, late results of laminectomy have been reported by Petit-Dutaillis, Ribadeau-Dumas and Messimy [715] and beneficial effects of laminectomy have been discussed by Carrot and David.[716]

The surgical technic of removing disk protrusions is discussed in two articles [717] from the military services.

Defects of the Neural Arch and Spondylolisthesis.—Few articles on this subject appeared during the year. Galluccio,[718] in the routine roentgenographic examination of 142 persons, found 15 with prespondylolisthesis or spondylolisthesis. The subjects consisted of soldiers exposed to many types of hazards and of an average age of 28 years. Galluccio expresses the belief that spondylolisthesis and prespondylolisthesis are much more prevalent than is ordinarily recognized and that diligent search for the isthmus defect will reveal it in many unsuspected cases. He describes in detail the roentgenographic findings in spondylolisthesis and prespondylolisthesis in roentgenograms made in the anteroposterior, lateral, oblique and lumbosacral projections. He considers the oblique view extremely important for diagnosis and calls attention to a "bow tie" appearance presented by the superior articular process, the pars interarticularis and the inferior articular process of each lumbar vertebra.

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715. Petit-Dutaillis, D.; Ribadeau-Dumas, C., and Messimy, R.: Late Results of Laminectomy for Sciatica Due to Herniated Disks, Rev. neurol. **74**:225-226 (July-Aug.) 1942.

716. Carrot, E., and David, M.: Surgical Therapy of Stubborn Sciatica in Young Adults: Relative Rarity of Hernia of Intervertebral Disks; Beneficial Effects of Laminectomy, Rev. neurol. **74**:281-282 (Sept.-Oct.) 1942.

717. Shelden, C. H.: Protruded Intervertebral Disk: Advantage of Upright Position in Surgical Removal, U. S. Nav. M. Bull. **42**:1107-1110 (May) 1944. Robertson, R. C. L., and Peacher, W. G.: Herniated Nucleus Pulposus: Improvement in Operative Technic, Bull. U. S. Army M. Dept., August 1944, no. 79, pp. 76-77.

718. Galluccio, A. C.: Spondylolisthesis; General Consideration with Emphasis on Radiologic Aspects, Radiology **42**:143-158 (Feb.) 1944.

Caldwell [719] has analyzed 59 consecutive cases of spondylolisthesis. He thinks that pain in the lower part of the back may be caused by the neural arch defect even when slipping cannot be demonstrated and that in other cases spondylolisthesis may be asymptomatic even when the displacement is severe. Caldwell found that among patients with complaints of pain in the lower part of the back severe enough to require medical attention 1 out of 10 was likely to have prespondylolisthesis or spondylolisthesis; of patients referred to orthopedists after other conditions had been ruled out, 1 out of 5 had neural arch defects. Caldwell emphasizes the importance of roentgenograms and requires a minimum of three views, consisting of the direct anteroposterior view, true lateral view focused on the fifth lumbar vertebra and 35 degree anteroposterior view with the rays directed toward the head and centered between the sacrum and the fifth lumbar vertebra. He states that these roentgenograms will clearly define any neural arch defect with separation and most of those without separation. He states the belief that unilateral neural arch defects may require confirmation by 45 degree oblique lateral roentgenograms but that these are not essential for routine examination. Of the 59 patients 16 had prespondylolisthesis, and in 9 of these the defect was unilateral. Caldwell reviews the evidence on progressive slipping in spondylolisthesis and concludes that it seldom occurs in adult life. The cause of symptoms is probably the progressive narrowing of the intervertebral disk, with degenerative changes in the disk and proliferative changes in the bone about the intervertebral foramens. Symptoms produced by lumbrosacral arthritis, especially in middle-aged persons not engaged in heavy labor, can usually be adequately relieved by braces, corsets, physical therapy and postural exercises. Younger patients with disabling symptoms may require operative treatment; it probably would be sufficient to fuse the lumbosacral articulation alone instead of attempting to bridge from the third lumbar vertebra to the sacrum with a bone graft. When sciatic pain is associated with spondylolisthesis, the nerve root should be explored and decompressed, either by liberation from bony constriction or by removal of a protruded intervertebral disk. Caldwell suggests that from a theoretic viewpoint the symptoms in certain cases might best be relieved by removal of the attached neural arch and the inferior articular processes. Liberation of the nerve roots without fusion of the articulations or bridging of the defect with a bone graft should be supplemented by postural exercises and support of the lower part of the back.

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719. Caldwell, G. A.: Spondylolisthesis; Analysis of Fifty-Nine Consecutive Cases, Tr. South. S. A. (1943) **55**:196-208, 1944.

Congenital Lumbosacral Anomalies.—Meredith [720] presents 3 illustrated reports of cases of spina bifida associated with lesions of the nerves producing serious symptoms which were relieved by neurosurgical treatment. Taylor [721] discusses common anomalies of the lumbar portion of the spine. Andre,[722] in Belgian literature, discusses spina bifida with neurotrophic changes in the lower extremities.

Technic of Spinal Fusion.—Individual variations in the surgical technic of spinal arthrodesis continue to be reported. Briggs and Milligan [723] advocate the use of many minute chips of bone packed closely together. In lumbosacral fusions King [724] has effected internal fixation by transfixing the articular facets with vitallium screws.

Ramser [725] described the use of a three-flanged nail in a transabdominal operation for nontraumatic spondylolisthesis.

Thomas [726] outlines the postoperative management of cases of fusion with and without hemilaminectomy.

Pain in the Lower Part of the Back.—Willis [727] (reviewed by John R. Cobb, M.D.), in a symposium on backache, reviews the structure and development of the spine and discusses the anatomy and variations and anomalies of the spine. He reports anatomic studies of seven hundred and forty-eight skeletons, some of which were previously reported in his other papers, and discusses the upright posture and its effect on the lower part of the back and symptoms low in the back.

He points out that since man's back is liable to defects and anomalies of growth and development and because an evolutionary shortening of

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720. Meredith, J. M.: Unusual Congenital Anomalies of Lumbosacral Spine (Spina Bifida) with Report of Three Cases, J. Nerv. & Ment. Dis. **99**:115-133 (Feb.) 1944.

721. Taylor, W. B.: Congenital Anomalies of Lumbar Spine, J. Canad. M. Serv. **1**:529-534 (Sept.) 1944.

722. Andre, M. J.: Sporadic Plantar Mal Perforant and Pes Cavus: Question of Lumbosacral Syringomyelia or Myelodysplasia, J. belge de neurol. et de psychiat. **41-42**:340-354, 1941-1942.

723. Briggs, H., and Milligan, P. R.: Chip Fusion of Low Back Following Exploration of Spinal Canal, J. Bone & Joint Surg. **26**:125-130 (Jan.) 1944.

724. King, D.: Internal Fixation for Lumbosacral Fusion, Am. J. Surg. **66**: 357-361 (Dec.) 1944.

725. Ramser, R.: Transabdominal Surgery for Non-Traumatic Spondylolisthesis, with Special 3-Flanged Nail and Replacement of Intervertebral Disk by Substantia Spongiosa Following Preliminary Extension Reduction, Helvet. med. acta **10**:365-375 (June) 1943.

726. Thomas, G. L.: Post-Operative Management of Fusion With and Without Hemilaminectomy, S. Clin. North America **24**:599-602 (June) 1944.

727. Willis, T. A.: Structure and Development of the Spine, J. A. M. A. **125**: 407-412 (June 10) 1944.

the vertebral column at the lumbosacral junction is still going on and this same part has been particularly involved in the transition from the pronograde to the upright posture, it is particularly apt to develop symptoms of strain and irritation of nerve roots of mechanical origin.

The importance of adequate roentgenographic studies and interpretations is stressed, and reproductions illustrate the various types of congenital variations.

In studying several hundred macerated skeletons, he found that beginning at about the thirty-fifth year of age there is a progressive lipping and calcification at the peripheries of the verterbal bodies and of the joints at the attachments of the synovial membrane and ligaments. This is most pronounced in thick-boned, heavy skeletons and least so in the long slender skeletons. It appears first and to the greatest degree in the sacroiliac and lower lumbar areas. In the former it ultimately results in calcification of the anterior sacroiliac ligament, which usually starts at the pelvic brim and extends toward the upper and the lower poles of the joint, often resulting in complete bridging and bony ankylosis of the joint. Because this bridge is thin and has a background of thick dense bone, it often is not shown on roentgenograms. Its presence is suggested by a hazy appearance, with indistinctness of outline of the joint. In the lumbar and lumbosacral areas the hypertrophic process involves particularly the vertebral bodies and often progresses to ankylosis of adjacent segments. It also involves the articular process but is more difficult to show here in roentgenograms.

He expresses the belief that since spondylolisthesis has not been found in a fetus or in any of the anthropoids it apparently is due to assumption of the upright posture or to some human custom in the care of infants, and the etiology is still under dispute. As previously reported, he found a higher percentage of defects in the neural arch in the spinal columns which showed an increased number of presacral segments.

Although a reverse spondylolisthesis, or backward displacement of the last lumbar vertebrae on the sacrum, has been described by several authors, after careful analysis of their descriptions and illustrations he is of the opinion that this diagnosis is based on faulty interpretation of the roentgenograms and is really an optical illusion due to the difference in anteroposterior depth of the last lumbar and first sacral vertebral bodies.

Jostes [728] (reviewed by John R. Cobb, M.D.) feels that in recent years the surgical approach in the treatment of painful irritation in the

728. Jostes, F. A.: Place of Manipulative Procedures in the Overall Treatment Rationale for Painful Back Condition, Arch. Phys. Therapy **25**:716-720 (Dec.) 1944.

back and sciatic region has done much to mask the rationale of conservative treatment and that since it has been proved that operation is not always indicated for disk involvement and in many cases is futile it may be well to summarize a few facts about the conservative treatment of disabling conditions of the back.

He states that it is well known that backache may be the result of any of a large number of causative factors, and he gives a brief outline of the causes of backache, listing them under the main headings of (1) diseases, (2) congenital anomalies, (3) trauma and (4) postural defects.

He discusses the various conditions under these main groups and feels that in only a small percentage of cases is surgical intervention really indicated. He discusses over-all methods of treatment and suggests methods of active treatment, comprising rest in bed, heat, massage, manipulations, support, exercise and operation. He reports observations on a large series of cases in private practice and in four dispensaries from 1930 through 1941 and in the military service from 1941 to 1944. About 90 per cent were seen before 1941 and about 10 per cent after that year. Of the total, the condition in about 65 per cent was not acute (not necessarily the first attack) and in 35 per cent chronic (not necessarily because of repeated attacks, since frequently the first attack was of chronic nature). Treatment was carried out by hospitalization methods in about 15 per cent of cases, by semiambulatory methods (home treatment ranging from total to partial rest in bed) in about 50 per cent and by ambulatory methods in about 35 per cent.

He outlines the methods of treatment utilized in this series of cases:

I. Bed rest (at least for a time), in about 66 per cent.

II. Application of heat, infra-red mostly, in about 35 per cent.

III. Massage—Extensive, in about 5 per cent. Limited in about 65 per cent as part of the manipulative procedure.

IV. Exercise after subsidence of acute exacerbations, in about 30 per cent (exercise of muscles whose increase in development was essential to maintain posture correction; also exercises to maintain wide range of motion of joints as a guard against further attacks due to overt acts in which a wide range of motion would be suddenly carried out and an acute exacerbation of back pain thus precipitated).

V. Use of artificial supports—

A. Temporary (one week to three months), in about 15 per cent (types of support: wide stockinet bandage, Osgood brace and simple wide canvas belt with or without pads).

B. Permanent (more or less), chiefly for women (corsets), in about 8 per cent (an Osgood brace or Goldthwaite brace used alone or in addition to corsets for women; often two heavy, wide mental stays plus one cross bar were used

to obtain more rigidity than ordinary heavy boning of the back of a corset could offer).

C. Shoe supports and changes in about 16 per cent (these included raising and lowering of heels, lifts and wedges).

VI. Manipulation without anesthesia, in about 65 per cent.

VII. Prescription of postural changes, in about 40 per cent (postural rest periods on any flat firm surface; postural corrections, standing and sitting and lying down).

VIII. Operations, in about 5 per cent (operation for ruptured nucleus pulposus, in 1.4 per cent; stabilizing operation because of anatomic weakness, in 2.5 per cent; stabilization operation because of disease, in 1.1 per cent.

Jostes feels that in regard to ruptured nucleus pulposus, after these years of trial the number of cases will be reduced in the future. He feels that the advantage of employing manipulative technic without anesthetic is that the conscious patient is an efficient check on the amount of force necessary and the patient often supplies a ready signal to let the operator know when the reduction as such has been accomplished or relief comes. He expresses the belief that every well trained practitioner of medicine should know that manipulation may afford relief or partial relief if it is indicated and is properly carried out.

ED. NOTE (J. R. C.).—It is well to bring out from time to time the significance of conservative treatment as this author has done. A high percentage of patients with painful conditions in the back can be relieved by conservative methods, and too frequently the orthopedic surgeon is inclined to think in terms of operative procedures, without giving the patient an adequate trial of conservative measures. Even though the roentgenograms show some definite defect, it does not necessarily follow that that is the cause of the patient's complaint and it may be only a concomitant occurrence.]

Mock [729] (reviewed by John R. Cobb, M.D.), in an introduction to a symposium on injuries of the back, makes a plea for better study and treatment for the rehabilitation of patients with pain in the lower part of the back. He expresses the opinion that there is no field in medicine or surgery in which changing styles in diagnosis and treatment have been so numerous as in this condition of pain low in the back, recalling such popular diagnoses as "railway spine," "sacroiliac sprain" and the present "herniated disk." He admits that surgical treatment is necessary for the relief of certain definite conditions, such as cord tumors, but stresses the point that to select patients who need these more complicated or radical surgical procedures is the greatest problem con-

729. Mock, H. E.: Back Injuries: Introduction, Radiology **41**: 551-553 (Dec.) 1943.

fronting surgeons today. He emphasizes the importance of careful study to avoid the overlooking of the psychogenic causes, the postural causes, the muscle imbalance and the numerous constitutional causes that are the predominant factors in the average run of cases of pain in the lower part of the back.

XXI. Conditions Involving Shoulder, Neck and Jaw

PREPARED BY A. STEINDLER, M.D., IOWA CITY

Lesions Due to Injury and Disease of Bursae and Tendons About the Shoulder Joint.—In regard to motion about the shoulder joint, Fisk[730] proposes to show that practically 50 per cent of motion at the shoulder joint occurs as a result of the movements of the scapula and the clavicle and not so much of those of the scapulohumeral joint. Roentgenograms taken in eight key positions demonstrate this fact, and the technic is also described.

Movements of the scapulohumeral joint are limited to 90 degrees of rotation with arm by the side, rotation of 90 degrees with the arm abducted, no movement at all with the arm vertically elevated, abduction of 90 degrees in coronal plane and elevation of 90 degrees in the sagittal plane.

Hamsa[731] discusses the intricate construction of the shoulder joint and the relationship of capsules and tendons to that joint. The bursa about the joint is discussed, especially the subacromial, and the diagnosis of conditions affecting this bursa and surrounding periarticular structures. Diagnosis and its relationship to applied anatomy of conditions involving the shoulder is the main theme of this paper. Physical therapy is recommended for treatment.

A discussion of injuries occurring in conjunction with the various periods of training of the parachutist was presented by Lord and Coutts.[732] The four stages are calisthenics with rope climbing, tumbling and jumps from mock towers, daily jumps from 250 foot (76 meters) towers and jumps from planes. Rope climbing produces tears in rectus abdominis muscles, with symptoms simulating appendicitis, with

730. Fisk, G. H.: Some Observations of Motion at Shoulder Joint, Canad. M. A. J. **50**:213-216 (March) 1944.

731. Hamsa, W. R.: Diagnosis and Treatment of Common Shoulder Disabilities, Omaha Mid-West Clin. Soc. **5**:88-90 (Aug.) 1944.

732. Lord, C. D., and Coutts, J. W.: Typical Parachute Injuries: Study of Those Occurring in 250,000 Jumps at Parachute School, J. A. M. A. **125**:1182-1187 (Aug. 26) 1944.

90 per cent of the injuries in the right rectus. Tumbling produces acromioclavicular separation. . The mechanism of this injury is discussed. In the third and fourth group, because of changes in technic of landing, the typical injury has changes from trimalleolar fractures of the ankle to upper fibular fracture or dislocation of head of fibula. The mechanics of such fractures and dislocations are discussed.

Standards of parachute schools and selection of candidates are discussed.

Garceau [733] discusses the frequent "homely" complications occurring in and about the shoulder joint in prolonged immobilization of this joint secondary to injuries of elbow, forearm and hand. Personal instructions to patients so that adequate home physical therapy is carried out will prevent many complications. Periarthritis is a frequent complication. Reports of cases are presented.

Operative repair of ruptures of the supraspinatus tendons is advocated by Jones,[734] in an article in which he discusses complete supraspinatus rupture. He points out that the injury is rarely diagnosed in living persons, while postmortem statistics show 15 to 20 per cent in unselected cadavers of persons over 30 years. Subacromial bursitis, bursal calcifications, periarthritis and rupture of the long head of the biceps are frequent complications and sequelae that accompany and mask rupture of supraspinatus tendon. Chronic painful shoulders that do not respond to conservative treatment should be explored by means of a Cubbins transacromioclavicular incision. This allows proper exposure for recognition as well as repair. Frequently accompanying tendons are torn along with the supraspinatus.

A posterior approach to the shoulder joint is discussed by Rowe and Yee.[735] The patient is placed face down, with a pillow under the chest and with the arms outstretched. The incision begins at the junction of the middle and inner thirds of the spine of the scapula and extends along the spine and posteriorly over the shoulder joint. The deltoid attachment to the spine of the scapula is divided by sharp dissection and split 1½ inches (3.8 cm.) from the medial border for 3 inches (7.6 cm.) to avoid injury to the nerve and to the muscle. The infraspinatus and the teres minor muscle are exposed and separated and the former freed from the capsule and divided at its tendinous attachment ½ inch (1.2 cm.) from the humeral tuberosity. The capsule

733. Garceau, G. J.: Shoulder Complications in Injuries of Elbow, Forearm or Hand, Proc. Interst. Postgrad. M. A. North America (1942) 1943, pp. 300-302.

734. Jones, L.: Complete Rupture of Supraspinatus Tendon: Simplified Operative Repair, Arch. Surg. **49**:390-398 (Dec.) 1944.

735. Rowe, C. R., and Yee, L. B. K.: Posterior Approach to Shoulder Joint, J. Bone & Joint Surg. **26**:580-584 (July) 1944.

is then opened. Two cases are presented in which the operation was used for open reduction of posterior dislocation of the shoulder.

Sycamore,[736] in five hundred routine examinations of the chest of the freshman class at Dartmouth College, found a definite rhomboid fossa present when a double contour could be seen on the roentgenogram. An incidence of 121 cases, or 24 per cent, was revealed; in 58 per cent there was bilateral fossae, and in 42 per cent there was a unilateral fossa. The fossa can be either shallow or deep and is situated 1 to 3 cm. from the sternal end of the clavicle. Its various forms are illustrated.

A more concise terminology for periarthritis, based on cause, pathologic changes and clinical picture, is suggested by Tarsy.[737] Two forms of therapy have been employed for the treatment of this deformity: (1) injection of the specific muscular and tendinous structures involved and (2) block anesthesia and manipulation.

Thirty-four patients were treated; 27 obtained freedom from pain and complete mobility, 3 were partially helped and 4 obtained unsuccessful results.

Lippmann[738] makes an important contribution in calling attention to the frequency of bicipital tenosynovitis in cases of periarthritis. He has studied 32 cases of so-called frozen shoulder. In all instances the subacromial bursa and the underlying musculoaponeurotic cuff were carefully explored and their condition noted and the bicipital tendon was exposed by incision through the deltoid.

In 2 cases only tears of the cuff were encountered, 1 partial and 1 complete. In 2 cases bursal adhesions without tears of the cuff were encountered. In all other cases the appearance of the synovia of the subacromial bursa was smooth and glistening; the sac contained no fluid, and there were no adhesions. Lippmann also found the underlying musculotendinous cuff entirely normal.

On the other hand, all cases in which exploration was done showed inflammatory changes in varying degrees involving the biceps tendon and sheath. There was, furthermore, in these cases a variable degree of impairment of motion of the biceps tendon in its groove caused by peritendinous adhesions. In the early cases, the tissues were reddened, vascular and edematous and the tendon was swollen and discolored. In the more chronic cases, the sheath was thickened, fibrotic and less vascular and the tendon was roughened and scarred.

736. Sycamore, L. K.: Common Congenital Anomalies of Bony Thorax, Am. J. Roentgenol. **51**:593-599 (May) 1944.

737. Tarsy, J. M.: Periarthritis of Shoulder Joint: Classification, Pathology and Treatment, New York State J. Med. **44**:2109-2117 (Oct. 1) 1944.

738. Lippmann, R. K.: Bicipital Tenosynovitis, New York State J. Med. **44**:2235-2240 (Oct. 15) 1944.

The striking fact was that in the early cases the tendon was still movable but that in the majority of the later cases it had become firmly bound down to the humerus with strong adhesions.

Lippmann feels that bicipital tenosynovitis is a pathologic change encountered with great frequency in the so-called frozen shoulder. The question is whether this is the underlying pathologic factor. The ultimate fusion of the tendon to the biceps groove suggests the explanation for the spontaneous cure, which so often occurs. In this connection, it is interesting to recall that Horowitz found in four of fifty anatomic dissections of shoulders fusions of the biceps tendons to the lesser tuberosity with rupture of the intra-articular portion.

In respect to the treatment, it would follow that a forced brisement in the early part of the illness is useless and tearing of the soft adhesions in the presence of pronounced inflammation serves only to cause more pain and more adhesions.

The author states that his experience with roentgen ray therapy in mild analgesic doses in over 30 cases was disappointing.

On the other hand, in the latter part of the disease the forcible manipulation with the patient under anesthesia occasionally produces startling results. Loud snaps are audible during the procedure, probably from the result of rupture of the attenuated and functionless intra-articular tendon.

However, he states the belief that stretching of the arm at regular intervals, with active exercise, is more logical. A surgical method which suggests itself is firm suture of the involved tendon to the adjoining lesser tuberosity. In operations performed during earlier stages of the frozen shoulder, the tendon is still mobile, and prompt relief from pain and improvement in the shoulder result. Motion follows rapidly.

From Lippmann's surgical investigation of more than 30 cases, it seems that involvement of the biceps tendon in most instances of frozen shoulder is a major factor and should be given special consideration when a specific diagnosis is being made and that in most instances the bursa and underlying cuff are not involved.

The susceptibility of the long head of the biceps tendon to both specific and nonspecific infections is discussed by Schrager [739] with regard to the anatomic factors, physiologic factors and pathologic factors. Painful or frozen shoulders in the absence of bursitis or pathologic changes of the joints are due to tenosynovitis of the long biceps tendon. Syphilis of tendons and tendon sheaths is discussed with regard to history. Etiology and diagnosis are mentioned, and the pathologic

739. Schrager, V. L.: Syphilis of Tendon of Long Head of Biceps Muscle and of Olecranon Bursa, Arch. Surg. **48**:423-428 (June) 1944.

picture of the presence of nodules in the tendon in syphilis is discussed. They are painless and movable and are a tertiary manifestation. Thick tendons seem to have a predilection in syphilis. Bursitis due to syphilis is also discussed, and the subpatellar and the prepatellar bursae are mentioned as common sites. Syphilis of bursae and tendons should be suspected more often in the diagnosis of tendinitis and bursitis.

Guido [740] presents a short review of the current methods of treatment for subacromial bursitis with associated calcareous deposits. He advocates operative removal in cases in which the deposit does not disappear spontaneously. The result is immediate, with complete relief, and Guido has not seen any recurrent lesions from the operation.

Pelner [741] discusses acute subdeltoid bursitis and suggests intravenous injection of 5 cc. of ferric cacodylate. He states that treatment is so effective that if relief is not obtained immediately then the diagnosis of bursitis is incorrect. Seventy-five patients were treated over a five year period. Duration was no handicap. Two to five treatments were necessary at three day intervals. Complications due to toxicity were negligible.

Young [742] presents a case of calcified bursitis of the elbow joint successfully treated with roentgen rays and diathermy. The patient made a complete recovery, and the calcareous deposits gradually diminished. This case is presented because of the almost immediate relief of pain under treatment. He refers to Baird's report of 44 cases of calcified bursitis, which showed that in the acute stage symptomatic improvement occurred in the majority of cases within seventy-two hours with one treatment and that in the chronic cases three treatments at intervals of four weeks were necessary for relief. He also refers to Klein and Klemes's report of 25 patients with bursitis treated by roentgen rays, with only ten days of average disability, whereas for 25 patients treated by other means the average disability was fifty days.

In the discussion, Popp emphasizes that in calcareous deposits in bursae of the shoulder joint acute lesions respond more rapidly than chronic ones, and he states that roentgen ray treatment was applied in many instances at the Mayo clinic in both acute and chronic cases, with or without calcification, and that it is a safe and economical

740. Guido, F. R.: Acute Calcified Subacromial or Subdeltoid Bursitis, California & West. Med. **60**:69-72 (Feb.) 1944.

741. Pelner, L.: Acute Subdeltoid Bursitis: Experiments with Iron Cacodylate, Indust. Med. **13**:826 (Oct.) 1944.

742. Young, H. H.: Calcified Bursitis, Proc. Staff Meet., Mayo Clin. **19**:250-253 (May 17) 1944.

procedure even though the presence or absence of the calcareous deposits has no effect on the end results.

Injuries and Disease of Acromioclavicular Joint.—Oppenheimer [743] states that roentgenograms show that there is motion in the acromioclavicular joint during all movements of the arm except pronation and supination. The technic of roentgenologic determination is described as well as the normal appearance of the joint. Mention is made of acromial fractures and acromioclavicular separations. Arthritis of this synovial or diarthrodial joint is discussed. The incidence, clinical manifestations and treatment are discussed, though few statistical data are given.

In the treatment of acute acromioclavicular separations, Wolin [744] discusses the use of the modified Hunkin method of splinting acute acromioclavicular dislocations by the use of a body cast and straps over the affected shoulder to exert downward pressure on the clavicle. A torso cast is applied, allowing free use of the upper extremities, over a padded strap which runs over the shoulder and under the cast anteriorly and posteriorly and is long enough to be buckled over the shoulder again, thus exerting as much force as may be needed to reduce the dislocation. Four to six weeks of immobilization is necessary. The author treated 10 men with this method, with all returning to duty after an average time of six to eight weeks.

Giannestras [745] presents a type of strap brace which he has found to work satisfactorily in reduction of a fresh separation of the acromioclavicular joint and maintenance of the reduction. The straps are arranged so that the downward pull from the weight of the extremity and the upward pull of the sternocleidomastoid muscle are counteracted. Straps go over the padded shoulder: one, a vertical strap, attached to the forearm just distally to the elbow with the arm at 90 degrees and the other enveloping the chest, running through the opposite axilla.

Birkett [746] reports a case of acromioclavicular dislocation in a man aged 29 years, in whom not only were the ligaments of the acromion torn but the outer end of the clavicle was forced under and buried in the trapezius muscle, where it remained trapped. Open reduction and freeing of the clavicle were done, and a strip of fascia lata was used

743. Oppenheimer, A.: Lesions of Acromioclavicular Joint Causing Pain and Disability of Shoulder, Am. J. Roentgenol. **51**:699-706 (June) 1944.

744. Wolin, I.: Acute Acromioclavicular Dislocation: Simple Effective Method of Conservative Treatment, J. Bone & Joint Surg. **26**:589-592 (July) 1944.

745. Giannestras, N. J.: Method of Immobilization of Acute Acromioclavicular Separation, J. Bone & Joint Surg. **26**:597-599 (July) 1944.

746. Birkett, A. N.: Result of Operative Repair of Severe Acromioclavicular Dislocation, Brit. J. Surg. **32**:103-105 (July) 1944.

to fix the clavicle, acromion and coracoid process of the scapula. Reduction was satisfactory and motion good. The fascial strip became calcified in eight months.

Repair of Habitual Dislocation of the Shoulders.—Several articles appeared in the Scandinavian journals dealing with the method of treatment of habitual dislocation of the shoulder. Ramser [747] describes a technic first described in 1936, which, again, is based on the principal of Eden except that Ramser uses rustless steel for the blocking.

Brun [748] recommends a procedure which is essentially that advocated by Eden and consists in the insertion of a tibial graft into the anterior rim of the glenoid. Brun has performed operation with the extra-articular graft method in 50 cases since 1931; 1 patient had a recurrence. In all other cases so far as he could follow them (he does not give the percentage of cases followed), there have been no recurrences.

Henderson [749] presents the latest statistical reports on Henderson's suspension operation, comprising fifty-five tenosuspensions performed on 51 patients. The end results were 91 per cent successful in patients having been observed for more than one year. There are some points Henderson makes in regard to the causes of failure: First, in epileptic patients one should first control the convulsions; then, in regard to the technic, he emphasizes that the tendons should be long enough and tied under proper tension and a transplanted piece should be deeply placed close to the bone.

Injuries, Deformities and Diseases about the Neck.—Chandler and Altenberg [750] report an extensive study of torticollis. They stated the belief that the pathologic changes are limited to the sternocleidomastoid muscles and that the associated deformities of the face, head, ear and cervical portion of the spine are secondary. The changes may be present at birth or may not be noted until after the tenth to the fourteenth day, when a hard fusiform swelling is found in the sternocleidomastoid muscle. The delivery is usually abnormal and most usually a breech presentation. The swelling increases in size for two to three weeks, when it reaches the size of an almond. It then begins to regress, and it may be gone entirely in the course of four to five

747. Ramser, R.: Treatment of the Habitual Dislocation of the Shoulder with a Metal Bar Anchored into the Neck of the Scapula and Coracoid Process, Helvet. med. acta **10**:377-380 (June) 1943.

748. Brun, H.: Technique and End Results of the Extra-Articular Graft Plasty in Habitual Dislocation of the Shoulder, Helvet. med. acta **11**:495-500 (June) 1944.

749. Henderson, M. S.: Tenosuspension Operation for Habitual Dislocation of the Shoulder, Proc. Staff Meet., Mayo Clin. **19**:5-10 (Jan. 12) 1944.

750. Chandler, F. A., and Altenberg, A.: "Congenital" Muscular Torticollis, J. A. M. A. **125**:476-483 (June 17) 1944.

months. The muscle feels short and hard and is noncontractile. The head is tilted to the affected side, and the chin is rotated to the unaffected side. Owing to the position of the head, it becomes foreshortened in the oblique fronto-occipital diameter. The level of the eyes changes, the mastoid process becomes more prominent, and the clavicle and shoulder become elevated on the affected side. A low cervical, high dorsal scoliosis may develop, with the convexity on the involved side.

Gross Pathology: The tumor is the fusiform swelling involving the whole muscle. The size of the mass may be from 2 to 6 cm. by 1 to 1.5 cm. It is firm and has the texture of cartilage or fibrous tissue.

There is replacement of muscle tissue by fibrous tissue. The few muscle cells remaining show various stages of degeneration, with vacuolation and many nuclei, absence of striation and changes in their straining properties. Some even show calcification. Great masses of fibrous tissue and fibrocytes are present. No hemorrhage is present. As age progresses, nothing remains but fibrous tissue with nuclei in parallel rows.

In order to clear up the anatomic basis for this condition, the authors injected veins and arteries of the neck in 5 stillborn fetuses. They found that the sternocleidomastoid muscle was made of five to six muscle bellies: (*a*) superficial sternomastoid, (*b*) superficial sterno-occipital, (*c*) superior cleido-occipital, (*d*) deep sternomastoid and (*e*) double deep cleidomastoid.

Nerve supply is from somatic and visceral motor branches, though the motor branches come from the spinal accessory. It also receives branches from the second, third and fourth cervical nerves.

Blood Supply: The occipital branch of the posterior auricular artery supplies the upper portion. The sternomastoid artery or muscular branches from the occipital artery also supply the upper portion. The sternomastoid branch of the thyroid artery supplies the middle and lower one third of the muscle. The transverse scapular artery supplies the lower portion of the muscle. The transverse cervical artery supplies the lower lateral portion.

Veins: The venous drainage of this muscle is into all the veins of the neck—interior and exterior jugular, anterior jugular, transverse scapular occipital, posterior auricular and anterior and posterior facial veins.

Etiologic Theories: There are a number of theories of causation: (1) abnormal pressure on head and neck during intrauterine life; (2) heredity (defective formation of the anlage of the sternocleidomastoid muscle); (3) neurogenic; (4) infection (no evidence to confirm it); (5) trauma during birth (the authors do not think the pathologic changes are due to hematoma); (6) ischemia of muscle during delivery, and (7) venous occlusion.

The authors give a rather long but comprehensive summary of the possible causes of torticollis. These may be found in the original article. One hundred and one patients are reported. Early operation is advocated. [ED. NOTE (L. D. B.).—The reading of this report *in toto* is recommended.]

Basilar impression symptoms and roentgenologic findings in atlas and axis abnormalities are discussed by Saunders.[751] This syndrome may mimic (1) syringomyelia, (2) progressive spastic paralysis, (3) shortening of the neck or (4) multiple sclerosis. Roentgenograms may show deformities of the foramen magnum, the base of the skull, the atlas and the axis, fusion of bodies of upper cervical vertebrae and fusion of the anterior arch of the atlas to the occipital bone. In addition, there may be a change in the relation of the axis, with the odontoid above its normal level, which level, he says, is a line joining the posterior margin of the hard palate and the dorsal margin of the foramen magnum. This line is called the "Chamberlain line."

The author took one hundred lateral roentgenograms of the skull to verify the presence of a basilar impression. He used the "Chamberlain line" as a basis and listed his findings positive or negative as to whether the odontoid was above or below the line. The normal odontoid is usually 1 mm. below the line. When deviations are found above the line, especially several centimeters, the foramen magnum should be examined for abnormalities.

Custis and Verbrugghen[752] report on a case of basilar impression giving rise to symptoms indistinguishable from those of cerebellar tumor. They point out that this anomaly should be placed in the list of changes that must be ruled out in any patient in whom cerebellar tumor is suspected.

Wycis[753] states that platybasia, although known for a long time, is just recently becoming an entity commonly recognized.

Two types of platybasia are described: primary, the result of congenital or developmental anomaly, and secondary, the result of softening and molding. Of the latter, rickets, osteomalacia, hyperparathyroid and osteitis deformans (Paget's disease) have been described as causative factors.

The author reports the first case of platybasia due to Paget's disease. There were severe neurologic manifestations. The symptoms

751. Saunders, W. W.: Basilar Impression: Position of Normal Odontoid, Radiology **41**:589-590 (Dec.) 1943.

752. Custis, D. L., and Verbrugghen, A.: Basilar Impression Resembling Cerebellar Tumor: Case, Arch. Neurol. & Psychiat. **52**:412-415 (Nov.) 1944.

753. Wycis, H. T.: Basilar Impression (Platybasia): Case Secondary to Advanced Paget's Disease with Severe Neurological Manifestations; Successful Surgical Result, J. Neurosurg. **1**:299-305 (Sept.) 1944.

were relieved by high cervical laminectomy combined with suboccipital decompression.

Heublein [754] discusses various methods of aid in the diagnosis of traumatic lesions of the cervical portion of the spine. He discusses the use of the planograph and laminograph and states that they are of value in diagnosing pathologic fractures of the cervical portion of the spine. The laminograph is of importance in obliterating the shadow of metal braces or other orthopedic paraphernalia. The use of myelograms in the diagnosis of rupture of the cervical intervertebral disk is discussed. Heublein concludes that a thorough knowledge of the anatomy plus the proper roentgen technic is essential if accurate diagnosis of lesions of the cervical portion of the spine is to be obtained.

Injuries of the brachial plexus are discussed by Meadoff and Gray.[755] They present an outline of injuries of the brachial plexus under the headings of (1) traction injuries, (2) pressure injuries, (3) direct injuries, (4) toxic injuries, (5) lesions of the spinal cord and (6) hysteria. All the cases cited are industrial, taken from an orthopedic clinic at a shipyard.

Three cases of injury to the long thoracic nerve, 2 cases of injury to the scapular nerve and 1 case of combined injury to the suprascapular and the long thoracic nerve are cited. One case of postoperative injury to the brachial plexus is reported in which the arms were abducted to above head level while a compression fracture of the tenth dorsal vertebra was being reduced. Recovery was made except for some residual paresis of the deltoid muscle and 20 per cent winging of the scapula. Two cases of injury following dislocation of a shoulder, with no mention as to whether paralysis or paresis existed prior to reduction, are cited. One case of isolated injury to the axillary nerve by a fall is reported. One case of apparent avulsion of the roots of the brachial plexus is cited. This patient was treated by amputation of the extremity. One case of involvement of the long thoracic nerve and the suprascapular nerve following a serum reaction is reported. One case of bilateral involvement of the suprascapular and the axillary nerves as a result of arsenical poisoning is discussed. Meadoff and Gray suggest that the scalenus anticus syndrome is due to a stretch mechanism of the neurovascular bundle over the elevated first rib due to shortened scalenus anticus. The treatment in most of the cases was conservative, by means of physical therapy and faradic stimulation.

754. Heublein, G. W.: Roentgen Diagnosis of Traumatic Lesions of Cervical Spine, J. A. M. A. **126**:950-954 (Dec. 9) 1944.

755. Meadoff, N., and Gray, A. B.: Brachial Plexus Injuries, Physiotherapy Rev. **24**:10-18 (Jan.-Feb.) 1944.

Swank and Simeone [756] review the anatomy of the scalenus muscle and its relation to the cervical nerves. They point out that the scalenus, in its origin by four tendinous slips, from the third, fourth, fifth and sixth cervical vertebrae, lies directly over the exit of the cervical nerves. The nerve below is usually the one affected; thus the fourth cervical nerve will cause symptoms by pressure from the third, the head of origin. They point out that the scalenus medius muscle gets a similar origin, only from the posterior tubercles of the transverse process. The brachial plexus lies between these two muscles. Under normal conditions there is enough space for the plexus, but hypertrophy or spasticity of these muscles along with a cervical rib or along the seventh cervical transverse process will cause pressure on the plexus. The lower segments of the plexus are those most affected, because those higher can accommodate themselves in the soft muscle belly.

Clinical Consideration: There are two types: (1) the superior type, due to pressure on the upper, namely the sixth and seventh cervical roots, and (2) the inferior type, due to pressure on the eighth cervical and first dorsal roots.

The summary comprises 17 cases. In the superior type, the onset was sudden. There were sensory changes on the radial side of the hand and first, second and third fingers, weakness of the extensors of the fingers and wrist and pain, with muscle spasm of the shoulder, arm, forearm and neck. These symptoms may regress slightly and then recur. There may be wrist drop. There was also weakness of the flexors, pronators, supinators and the intrinsic muscles of the hand.

Another group complained of pain and muscle spasm, chiefly in the rhomboid, deltoid, triceps and teres major muscles and the extensors of the hand, wrist and fingers. The head was tilted to the affected side, and the shoulder was elevated. The muscles were tender, and small tender knots could be palpated. There was tenderness to pressure over the origin and insertion of the scalenus muscles.

Differential Diagnosis: The condition should be differentiated from herniation of cervical disk.

Treatment: Conservative treatment was first used. If this did not give relief, a tenotomy of the scalenus tendon was done.

Swank and Simeone describe the operation for scalenus anticus syndrome, which may be found in any textbook on surgery. They point out that the mechanism of pressure is similar to a vise, the upper end of the vise being a long transverse process or a cervical rib and the lower end being the scalenus anticus muscle. They support the theory of hypertrophy of the muscles through exercise. Often

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756. Swank, R. L., and Simeone, F. A.: Scalenus Anticus Syndrome: Types; Their Characterization, Diagnosis and Treatment, Arch. Neurol. & Psychiat. **51**:432-445 (May) 1944.

excessive breathing due to gunshot wounds of the lungs or pneumonia will cause hypertrophy of the scalenus muscles. A comprehensive study in detail is given at the end of this article.

Wartenberg [757] discusses acroparesthesia, a syndrome with features of transient paresthesias, anesthesias, pain in the upper extremity at night, absence of any neurologic or orthopedic signs and a long, benign, self-limited course. The symptoms occur more often in women of 40 to 55 years and come on at night, when the patient is supine. The differential diagnosis is mentioned. Roentgenograms may reveal spondylarthritis or long cervical ribs. Spondylarthritis as a diagnosis is challenged. The author believes that muscular pressure on the brachial plexus is the cause of the nocturnal paresthesias. Ulnar nerve distribution of the symptoms is most frequently seen. The author mentions the work of Schultze on acroparesthesias and discusses the different conceptions of the syndrome.

An excellent study of cervical intervertebral disks based on 12 operative cases is presented by Spurling and Scoville.[758] Lateral herniation of a cervical disk was found in each patient, and all were relieved of their radiating pain within two weeks following operation. The authors draw an accurate clinical picture, which on the whole tallies with that recently published by Semmes and Murphy. The principal points of the symptom complex are as follows: Pain and stiffness of the neck are usually the first symptoms. Often the pain is brought on by certain movements of the neck, coughing, straining or sneezing. It is usually made worse by the maintenance of a single position, and the points of maximum pain are at the base of the neck, the tip of the shoulder and in the arm down to the elbow. Pain may extend to the hand, but the paresthesia and numbness in the hand are more annoying than is the pain. The whole hand goes to sleep, feels cold and appears bluish. Sensory deficits may not be demonstrated by the usual clinical tests in the beginning, but if the compression is prolonged a sensory deficit can usually be demonstrated.

Objective muscular weakness may be difficult to demonstrate, but the patients do complain that the involved extremity is weaker than normal. When weakness can be demonstrated, it has great diagnostic significance. The biceps muscle is supplied by the fifth and sixth root. Consequently, when weakness of the biceps with normal function of the triceps muscle occurs in a lesion of the sixth cervical root, there is a herniated disk betwen the fifth and sixth cervical vertebrae, while

757. Wartenberg, R.: Brachialgia Statica Paresthetica (Noctural Arm Dysesthesias), J. Nerv. & Ment. Dis. **99**:877-887 (May) 1944.

758. Spurling, R. G., and Scoville, W. B.: Lateral Rupture of the Cervical Intervertebral Discs: Common Cause of Shoulder and Arm Pain, Surg., Gynec. & Obst. **78**:350-358 (April) 1944.

a weak triceps and normal biceps muscles would indicate a lesion of the seventh cervical root, with a herniation of the disk between the sixth and seventh cervical vertebrae. Furthermore, the lesions at the fifth cervical disk are associated with diminution and absence of the biceps reflex, whereas lesions of the sixth cervical disk are associated with diminution or absence of the triceps reflex. These points are important contributions to what is already known about the distribution of sensory changes and paresthesias as described by Semmes and Murphy.

Other important observations are spinal tenderness at the site of the lesion and the so-called neck compression test. The latter is chiefly a reproduction of characteristic pain and radicular features when the head is tilted toward the painful side and pressure is exerted on top of the head.

Spurling and Scoville then proceed to clear an analysis of the differential diagnosis between protrusion of the intervertebral disk, neoplasm, compression of the scalenus anticus muscle, cervical arthritis and similar conditions.

Valuable evidence is given by roentgenologic examination. The lateral roentgenograms usually show narrowing of the involved interspace, with loss of the normal lordotic curve, even in hyperextended positions. The oblique views may show narrowing of the intervertebral foramens with proliferating osteophytes.

The myelographic examination with Pantopaque is an accurate method of diagnosing a ruptured disk. When the Pantopaque is injected (6 cc.) into the arachnoid space by lumbar puncture, the patient's head is fully extended by a small pillow placed under the chin before the table is tilted, so that the contrast material may not run into the basal cisternae of the skull. The head of the table is then tilted downward to permit the Pantopaque to collect in the cervical gutter. The defects are demonstrated by the writers in a number of roentgenograms.

Spurling and Scoville contend that conservative methods have an important place in the treatment, particularly if the symptoms are purely radicular and there is no evidence of compression. If the herniation is suspected to be a fairly large one, it is better to proceed with prompt operative intervention. The patients with milder disease may improve and may even get lasting relief by periods of rest in bed with halter traction. However, if after three or four days of this treatment there is no relief of either the radicular pain or the muscle spasm, then conservative treatment is useless. The authors are particularly against manipulation of the cervical portion of the spine.

After a description of the operative technic and postoperative treatment, the authors give the results as follows: The 12 patients operated

on were relieved of their radicular pain within two weeks following the operation, most of them earlier; and in each instance, with the exception of 1 case, the patient was able to return to military duties without disability.

The ratio of the lesions of the lumbar and cervical ruptured disks is about 12 to 1, the authors finding twelve cervical and one hundred and forty-three lumbar ruptured disks, verified by operations, during the first eleven months of 1943.

The distribution of pain between ruptures of the fifth and the sixth cervical disk is quite different. In the sixth cervical disk, the pain radiates from the neck into the shoulder and arm, with paresthesia at the posterior aspect of the thumb. There is always a weakness or absence of the tendon reflex of the biceps brachialis. In the sixth cervical disk, however, the pain radiates from the neck into the shoulder and arm, with paresthesia of the index, middle and perhaps ring fingers and the tip of the thumb. The symptoms are aggravated when the head is tilted to the painful side.

Bucy and Chenault [759] present a case of herniated cervical intervertebral disk. The patient was injured when he fell on an icy street. The clinical syndrome consisted in repeated attacks of severe pain in the scapular region and persistent paresthesias of the thumb and index fingers and the radial border of the forearm. The herniation was confirmed surgically and found to have occurred between the sixth and seventh cervical vertebrae. After partial hemilaminectomy and excision of the disk, the patient had complete relief of symptoms.

Ulmer and Meredith [760] report 3 cases of herniation of cervical intervertebral disks.. The first 2 patients had lateral herniations of the seventh cervical disk, with compression of the eighth nerve root. Herniation was found at operation, and removal gave complete relief; 1 patient had precordial pain in addition to the radiating pain in the upper extremity. The third patient presented the neurologic picture of an extradural tumor of the spinal cord, with spastic paraplegia and subarachnoid block. This patient falls into Stookey's group of "syndrome of bilateral ventral pressure." At operation, the herniated disk was found and removed, with good results. The authors emphasize the importance of the "trigger point."

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759. Bucy, P. C., and Chenault, H.: Compression of Seventh Cervical Nerve Root by Herniation of Intervertebral Disk, J. A. M. A. **126**:26-27 (Sept. 2) 1944.

760. Ulmer, J. L., and Meredith, J. M.: Syndrome of Cervical Root Compression and Brachial Neuritis Following Lateral Herniation of Intervertebral Disk, with Comment on Central Midline Protrusions, Virginia M. Monthly **71**:119-124 (March) 1944.

Epstein and Davidoff [761] report on 5 patients who had verified herniated disks of the lower portion of the cervical part of the spine. The normal findings at myelographic examination with opaque oil in this region are described. Epstein and Davidoff feel that myelography of the cervical portion of the spine is a procedure which can provide valuable information. They express the opinion that it merits further study and evaluation. [ED. NOTE (L. D. B.).—The spinal canal in the cervical area is wide. A laterally placed disk may not be visualized in opaque myelograms.]

Peron, Lereboullet, Guillaume and Ribadeau Dumas [762] report the case of a 44 year old man who complained of pain in the right upper extremity followed by motor disturbance of the lower extremities. On examination there was a Brown-Séquard syndrome, hemiplegia of the leg and hemiparalysis of the arm on the right. On the left, there were sensory disturbances, which reached up to the fourth dorsal segment. A laminectomy was performed on the fifth, sixth and seventh cervical vertebrae. After the dura was opened, a herniated disk the size of a hazelnut was found and removed. Complete recovery followed, with the exception of the hypoesthesia on the left side. They also report on a 40 year old woman who complained of violent pain in the upper dorsal region, with radiation into the left arm, followed a month later by motor disturbances in the left lower extremity. The clinical examination showed the existence of the Brown-Séquard syndrome, motor changes on the left and sensory disturbances on the right. A laminectomy of the fifth and sixth cervical vertebrae demonstrated a herniated disk, which was removed. After the operation the symptoms disappeared except for slight defects in the left upper extremity and a persisting Babinski sign.

Management and Treatment of Injuries of the Jaw.—Thoma [763] presents an article reviewing the management and treatment of fractures of the jaw from World War I and World War II. This study should be of great interest to facial, maxillary and oral surgeons. Aside from the exhaustive presentation of former and present day methods in the management of fractures of the jaw, the most valu-

761. Epstein, B. S., and Davidoff, L. M.: Iodized Oil Myelography of Cervical Spine; Observations on Normal and on Five Patients with Ruptured Intervertebral Discs of Lower Cervical Spine, Am. J. Roentgenol. **52**:253-260 (Sept.) 1944.

762. Peron, N.; Lereboullet, J.; Guillaume, J., and Ribadeau Dumas, C.: Hernia of the Cervical Disc Producing Clinical Picture of Medullary Compression with Brown-Séquard Syndrome: Recovery After Operation, Rev. neurol. **74**:306-307 (Nov.-Dec.) 1942.

763. Thoma, K. H.: History and Treatment of Jaw Fractures from World War I to World War II: Collective Review, Internat. Abstr. Surg. **78**:281-312, 1944; in Surg., Gynec. & Obst., April 1944.

able contribution of the article is an imposing list of two hundred and fourteen references in the bibliography.

A discussion of the incidence of the various sites of mandibular fractures and their treatment by wiring is presented by Merrifield.[764] He describes, in not too great detail, the various types of maxillary and facial bone fractures and their treatment with various types of splints, such as the reversed Gunning splint, plaster head cap and wires. For the fractures of the nasal bones, nasal packs with molding is advocated. For the zygomatic fractures, Gillies' method is advocated.

Sweet [765] emphasizes the importance of examination of the condylar neck in all fractures of the jaw, due to the fact that this fracture can be readily missed. The technic consists of lateral views taken with the mouth open so that the central rays pass directly through the neck of the condyles. He also elaborates on the type of film and times of exposure best suited.

Strock [766] reviews the various methods of fixation of fractures of the mandible and presents a report on 2 patients treated as follows: An incision is made over the fracture site, along the alveolar ridge, and the mucoperiosteum is reflexed to reveal the fracture site. Burr holes are then made with a dental drill, and wires are passed through the holes and across the fracture site and cut off short. Primary suture of the flap of periosteum and mucosa is then done. [ED. NOTE (L. D. B.)—It is difficult to maintain fixation of any fracture with wire.]

The author feels that direct fixation is the method of choice in fractured edentulous mandibles when fractured fragments are accessible. He states that the tissues in this area tolerate tantalum and ticonium.

Van Zile [767] reports the use of a 10 gage iron wire coat hanger to apply traction as described by Erick. The reason for the use of this substitute was the unavailability of the ready-made splint on shipboard. The technic for making the appliance is described in detail.

The indications for extraoral fixation of fractures of the mandible are discussed by Parker.[768] The point emphasized is that it has its place in the treatment of fractures in which intraoral fixation is not possible or in which some function can be allowed if displacement is

764. Merrifield F. W.: Management of Jaw Fractures, Radiology **41**:539-542 (Dec.) 1943.

765. Sweet, A. P. S.: Radiology of Neck of Condyle, U. S. Nav. M. Bull **42**:1135-1139 (May) 1944.

766. Strock, A. E.: Inert Metals in Direct Fixation of Mandibular Fractures, Surg., Gynec & Obst. **78**:527-532 (May 1944.

767. Van Zile, W. N.: Technic for Building Head Cast Fracture Appliances from Coat Hangers, U. S. Nav. M. Bull. **42**:200-207 (Jan.) 1944.

768. Parker, D. B.: Skeletal Fixation in Treatment of Fractures of Mandible, S. Clin. North America **24**:381-391 (April) 1944.

slight. The appliances are all modifications of the Stader type of splint, using either threaded screws or pins. In insertion of the pins or screws, a point near the angle of the jaw or the external oblique ridge is selected. Resumption of chewing is not advised for the first few weeks. The splint may be removed in five weeks unless there are contraindications. The method is advisable for military personnel but not for civilian practice. It has the disadvantages of increasing chances for infection and also of leaving scars. [Ed. Note (L. D. B.).—Physiologically, what is the difference between military personnel and civilians?]

Greeley and Throndson [769] report a case in which the placement of a Roger Anderson pin for fracture of the jaw injured the underlying facial artery and vein and was followed by the formation of an arteriovenous fistula, which later had to be removed. The authors cite the case as a means of precaution in preventing the same occurrence in the future. [Ed. Note (L. D. B.).—An excellent way to prevent future occurrence is to discontinue the use of the pins.] He advises care in all cases with pin fixation, with reference to injury to arteries and veins at the time of insertion.

McLaren [770] describes a case of degeneration of the condyle of the left mandible in a man who had had repeated traumas to the jaw. The area was resected, with good results.

New and Erich [771] point out that because of the frequency of facial maxillary injuries bone grafting of jaws will become a comparatively common procedure. The authors describe the commonly known fact that bone grafts die and are subject to "creeping substitution." The two *sine qua non* factors for successful bone grafting of the jaw are absolute aseptic technic and a perfect fixation. The authors describe a number of appliances for fixation of the fragments, depending on whether the jaw is or is not edentulous and depending on the number of teeth available for fixation. They express general dissatisfaction with the vast majority of apparatus currently used.

Donor sites for bone grafting of the jaw are the tibia, crest of the ilium, ribs and clavicle. Sliding inlay grafts are also used.

They claim that although experimental evidence shows that excess of bone marrow in grafts is detrimental to tissues about a bone graft, they prefer cancellous bone to compact bone. In case of loss of soft tissue, this must be replaced before bone grafting is undertaken. This article is excellent from the point of view of supplying technical details.

769. Greeley, P. W., and Throndson, A. H.: Arteriovenous Aneurysm Resulting from Application of Roger Anderson Splint, J. A. M. A. **124**:1128 (April 15) 1944.

770. McLaren, J. W.: Bone Degeneration in Temporomandibular Joint: Case Report, Brit. J. Radiol. **17**:94-95 (March) 1944.

771. New, G. B., and Erich, J. B.: Bone Grafts to Mandible, Am. J. Surg. **63**: 153-167 (Feb.) 1944.

XXII. Research

PREPARED BY A. STEINDLER, M.D., IOWA CITY

Bone Growth Repair and Metabolism.—The effects of ascorbic acid on the healing of fractures are discussed in an experimental study by Roche and Martin-Poggi.[772]

As there is considerable difference of opinion among experimenters, it seemed appropriate to the authors to make new experimental studies in order to establish the role of vitamin C in the repair of fractures. Ashley Cooper called attention to the relation of the consolidation of fractures with absence of fresh food, and numerous authors have remarked on the absence of ascorbic acid and its adverse effect on callus formation. The action of ascorbic acid manifests itself principally in the formation of connective tissue in fractures and in the development of experimental granulomas. The experiments of the author have shown that the effect of ascorbic acid on the entire callus formation is as follows: 1. The organization of connective tissue matrix is influenced by ascorbic acid. 2. In the transformation of the connective tissue into the precallus formation as the preparatory stage to calcification, phosphatase plays the principal role. 3. In the formation of the bony callus itself the tricalcium phosphate plays a determining role.

In their experiments the authors made the following observations: 1. Lack of vitamin C produces in adult animals without fracture an absorption of bone. 2. In animals lacking vitamin C in which a fracture is produced, there is only a slight amount of connective tissue callus formed, the development of which stops rapidly and in a great number of cases becomes absorbed, so that the fragments are then united only by pseudarthrosis. 3. The lack of vitamin C in the rabbit causes considerable disturbance in the repair of fractures, while, in contrast, a fracture produced following a period of vitamin C privation will develop normally, with its initial absorption and increased high phosphatase development in the fragments, with consolidation as soon as vitamin C is added. Small quantities of ascorbic acid are sufficient. The authors obtained satisfactory results even with a daily dose of not more than 3 to 5 mg. Sometimes 1 or 2 mg. is sufficient for consolidation.

So far as the therapeutic application is concerned, it is evident that vitamin C is indicated only for persons with hypovitaminosis.

Since vitamin C has its effect only on the formation of connective tissues, its use, therefore, is indicated in the initial period of repair

772. Roche, J., and Martin-Poggi, R.: Effects of Ascorbic Acid: Experimental Studies, J. de chir. **58**:264-269, 1941-1942.

of fractures. No improvement in calcification can be expected, but rather there will be an acceleration in the formation of connective tissue only.

Blum [773] presents a paper in which the purpose is twofold: to determine (1) whether phosphatase activity is affected by the presence of various organic and synthetic substances and (2) whether phosphatase could be used to accelerate the deposition of bone in an experimental fracture. The inhibitory effect of many substances on phosphatase activity is described. The use of phosphatase together with its substance, glycerophosphate and an anchoring medium of alginate gel accelerates bone repair. Ectopic bone was formed in the muscle by the introduction of phosphatase, substrate and anchoring medium by injection.

Bourne [774] investigated the possible relationship between vitamin C and calcification in guinea pigs. It has been previously stated that vitamin C plays no part in the production of bone salt but is essential for the laying down of the organic matrix of bone.

The deposition of calcium in bone and the effect of vitamin C, vitamin P (citrin) and sodium citrate on such deposition are the subject of the experiments. Also, the alkaline phosphatase activity in scurvy is investigated.

Bourne shows that deposition of bone salt in normal and regenerating bone is retarded in scurvy, and this is corrected by addition of vitamin C. The closely related citrus and sodium citrate play no part in this process.

It is suggested that one of the functions of vitamin C is to allow production of a phosphatase-impregnated bone matrix.

Class and Smith [775] performed a series of experiments on 12 rats to determine the source of endogenous citric acid. The end studies showed that the excess of citric acid excreted by the kidneys after the administration of sodium bicarbonate and sodium malate did not originate in the skeleton but was a product of intermediary metabolism. This was a highly technical laboratory discussion.

Silberberg, Atherton and Copher,[776] in experimental observations, reveal that the administration of anterior pituitary extract accelerates the formation of cancellous bone occurring in the abdominal fascia

773. Blum, G.: Phosphatase and Repair of Fractures, Lancet **2**:75-78 (July 15) 1944.

774. Bourne, G. H.: Some Experiments on Possible Relationship Between Vitamin C and Calcification, J. Physiol. **102**:319-328 (Dec. 31) 1943.

775. Class, R. N., and Smith, A. H.: Skeleton as Source of Endogenous Citric Acid, J. Biol. Chem. **151**:363-368 (Dec.) 1943.

around the transplants of urinary bladder in young dogs. This effect represents another instance of an acceleration of a tissue time curve by anterior hypophysial hormone. The cartilage at the chondro-osseous junction of the ribs undergoes increased hypertrophy and regression under the influence of anterior pituitary extract, but its proliferation could not be stimulated in the young adult animals. The production as well as the resorption of bone could be temporarily increased by the hormone. The skeletal effects of the anterior pituitary extract in dogs are therefore similar to those exerted by this hormone in mice and guinea pigs.

The calcium-phosphorus and lead-phosphorus ratios in relation to deposition and absorption of lead have been investigated by Barrett.[777] Growth was retarded but not stopped by the addition of lead to the diet. Addition of phosphorus to a basal leaded diet resulted in a reduction of the circulating lead and in a deposition of lead in the bone. Addition of calcium to the basal leaded diet caused an increase in ash weight, and the level of lead in the blood was maintained at the same level as with the basal leaded diet without calcium. Less lead is deposited in the bone if the calcium-phosphorus ratio is high.

Duckworth and Godden[778] try to show that the increase in magnesium in bone ash which occurs in demineralization arises from a calcium-replacing action of magnesium. It does not occur if magnesium supplies are inadequate. If there is simultaneously a deficiency of calcium and magnesium, replacement does not occur. If after this period of calcium and magnesium starvation magnesium is restored to the body, then it begins to exert its calcium-sparing effect on the magnesium content of the skeleton. Although it may vary in bones, it does not vary in soft tissue.

The bioassay of the pituitary growth hormone by measurement of the width of the proximal epiphysial cartilage at the tibia was suggested by Evans and colleagues (*Endocrinology* **32**: 13 [Jan.] 1943). Marx, Simpson and Evans[779] now make a comparison between this hormone and other purified anterior pituitary hormones other than the growth

776. Silberberg, M.; Atherton, H. R., and Copher, G. H.: Effects of Bovine Anterior Hypophyseal Extract on Urinary Bladder Transplants in Young Dogs, Including Some Observations on Its Effects on Endochondral Ossification, Ann. Surg. **120**:680-688 (Oct.) 1944.

777. Barrett, F. R.: Studies on Deposition of Lead in Bone: Calcium-Phosphorus and Lead-Phosphorus Ratios, M. J. Australia **2**:433-435 (Nov. 27) 1943.

778. Duckworth, J., and Godden, W.: Replenishment of Depleted Skeletal Reserves of Magnesium, Biochem. J. **37**:595-598, 1943.

779. Marx, W.; Simpson, M. E., and Evans, H. M.: Specificity of Epiphyseal Cartilage Test for Pituitary Growth Hormone, Proc. Soc. Exper. Biol. & Med. **55**:250-252 (April) 1944.

hormone. Adrenotrophic hormone decreased the width of the cartilage. The thyrotrophic hormone, the mammotrophic hormone and pure thyroxin increased the width of the epiphysial cartilage slightly after a considerable time, but definitely less than a single dose of the growth hormone.

Sobel, Rockenmacher and Kramer [780] report a scheme of analysis of bone for small samples which need to be in powder form. It was desired to analyze the small bones of low ash content which were encountered in experiments on the composition of bone in young rats on experimental diets which produced rickets and poor growth. Such bones, containing relatively large amounts of organic matter, are difficult to reduce to powder, which is necessary for most methods of carbonate analysis.

The design of this scheme permits the various analyses to be made easily and precisely in a serial fashion on a single specimen weighing as little as 5 mg.

Calcium may be determined in quantities as minute as 102, phosphorus in even smaller amounts, 352 of carbonate to 1 part in 1,000 and concentrations of lower than 0.02 milliequivalents of total base, with less than 2 per cent error.

The authors discuss the various technics used.

Martin [781] reports on the clinical use of bone meal in doses of 20 grains (1.2 Gm.) daily in conjunction with minimum requirements of vitamins A and D, given to 57 children complaining of " 'growing pains' . . . whose parents stated that he or she kicked and screamed in the night." A similar number of patients were put on dicalcium phosphate. All the children on bone meal had complete remission of symptoms, while of those on dicalcium phosphate 35 still had complaints. After these were placed on bone meal, their symptoms disappeared. Martin reports that bone meal prevented leg cramps and dental cavities in pregnant women. Their babies had remarkably long finger nails and long silky hair and were healthy. Martin also uses bone meal for muscular cramps in both sedentary workers and laborers.

Sympathetic block in crush injuries is discussed by Thomson, Helwig and Sire.[782] They report on the objective physical and histopathologic observations made in over 100 experimental animals (albino rabbits), which were killed one hundred hours after severe crush fractures of the

780. Sobel, A. E.; Rockenmacher, M., and Kramer, B.: Microestimation of Inorganic Constituents of Bone, J. Biol. Chem. **152**:255-266 (Feb.) 1944.

781. Martin, E. M.: Report on Clinical Use of Bone Meal, Canad. M. A. J. **50**:562-563 (June) 1944.

782. Thomson, J. E. M.; Helwig, F. C., and Sire, E.: Sympathetic Block in Treatment of Local Shock: Experimental Study, J. Bone & Joint Surg. **26**:189-196 (Jan.) 1944.

right humerus in the midshaft. Four hours after the injury, one half of these animals received injections of 3 cc. of procaine hydrochloride (2 per cent) into the region of the right stellate ganglion. The remainder of the animals were used as controls and had no treatment. All of them were observed regularly at frequent intervals, and changes in temperature of both right and left upper extremities and evidence of swelling were recorded. Finally, at the end of one hundred hours, the animals were killed; the right upper extremities were amputated at the shoulder, and sections were taken of the tissue in the region of greatest injury. From these observations, it was concluded that procaine block of the sympathetic vasoconstricting mechanism in the severely injured extremities of experimental animals tends to restore the normal circulatory integrity to the extremity. It stimulates a more normal interchange of tissue fluids and excites capillary activity to carry away rapidly the tissue products after trauma. These experiments would seem to indicate that the blocking of the vasoconstriction sympathetic mechanism should be more frequently resorted to as an early therapeutic measure in the treatment of severely crushed extremities.

Inman and Saunders [783] investigated the threshold of sensitivity to painful stimuli of the various deeper structures in order to clarify the question of referred pain from skeletal structures. This was done qualitatively by introduction of needles, drilling with a Mathews wire and injection of weak solutions of formic acid and hypertonic solution of sodium chloride and quantitatively by the injection of buffered salt solution under known pressures. In a total of one hundred and sixty observations on 26 subjects it was found that the localization of pain produced by stimuli to the more deeply placed structures was increasingly poor. Periosteum had the lowest threshold of pain, followed in order by the ligaments, fibrous capsules of joints, tendons, fascia and, the least sensitive, muscle. Stimulation of the periosteum, ligaments and tendons caused extensive radiation of pain. Ofter pain is accompanied with severe vasomotor reactions. The radiating pain is similar to the pain produced at the point of stimulation except that there is a time lag of several minutes to several hours. The pain also is continuous along the path of its radiation. Stimulation of the same anatomic structure, whether it be periosteum, fascia or other structure, always results in radiation along the same path and in the same direction. The pain may radiate distally or proximally and may persist for several days, with exacerbation after even slight trauma. Because of the constancy in radiation, the authors mapped out areas to which the pain radiates and they call these areas the "sclerotomes"; these differ from the

783. Inman, V. T., and Saunders, J. B. deC. M.: Referred Pain from Skeletal Structures, J. Nerv. & Ment. Dis. **99**:660-667 (May) 1944.

dermatomes in distribution. A series of the various "sclerotomes" and dermatomes are pictured by Inman and Saunders. They suggest that pain from the deeper structures has no superficial cutaneous component and is not related to irritation of any major peripheral nerve. It is proposed that an obscure reflex mechanism brings about radiation of pain from the deep mesodermal structures, and the pathways are designated by the term "sclerotome."

Blalock [784] presents data (on trauma to tissues) from experimental work on animals. In one group, the application of the tourniquet was continuous during the experiment, whereas in the other it was intermittent. Before the tourniquet was applied, the extremity was repeatedly traumatized. In one of the groups the tourniquet was left in place for five hours, whereas in the other group the tourniquet was released for two minutes every thirty minutes. Of the first group, only 1 survived. In the second group, in which the tourniquet was released intermittently, 8 survived. Blalock offers this evidence as support to confirm the prevailing impression regarding the dangers associated with the prolonged use of a tourniquet on an injured extremity.

Muscles.—The effects of passive and active exercise on muscle tonus were investigated by Fries.[785] Active and passive exercise of specific muscle groups, by means of a special motor-driven ergometer bicycle, in 11 normal women was tested by a modified Martin strength test before and after twenty-one days of training. A short period of systematized daily training will produce a demonstrable increase in strength of these muscle groups, which are made to develop active tension during exercise. Purely passive exercise does not cause any significant change in muscle strength. It is suggested that there may be a physiologic relationship between muscle soreness during training and the subsequent increase in muscle strength.

Unna and Pick [786] state that thiamine hydrochloride in concentrations of 10 to 15 mg. per hundred cubic centimeters prevents the effect of nicotine on the isolated intestine of rabbits and guinea pigs and on the isolated skeletal muscle of the frog. The authors found that neostigmine does not counteract this effect. Thiamine only temporarily blocks the action of nicotine but does not permanently damage the ganglions. The cohibitory effect of thiamine is confined to the synapsis and to

784. Blalock, A.: Effects of Continuous and of Intermittent Application of Tourniquet to Traumatized Extremity. Arch. Surg. **48**:489-490 (June) 1944.

785. Fries, E. C.: Some Physiologic Effects of Passive and Active Exercise: Training Effects on Strength of Specific Muscle Groups, Arch. Phys. Therapy **25**:546-549 (Sept.) 1944.

786. Unna, K., and Pick, E. P.: Inhibition of Nervous Transmission in Synapses and End Plates by Thiamine, J. Pharmacol. & Exper. Therap. **81**:294-300 (July) 1944.

the receptive apparatus of the end plates at the myoneural junction. The other B vitamins, such as riboflavin, pyridoxine, pantothenic acid, nicotinamide and paraaminobenzoic acid, do not have the same effect on the action of nicotine. The effect of thiamine is linked to the thiazole structure of the molecule.

Thomsen and Luco [787] discuss the changes of weight and neuromuscular transmission in muscles of immobilized joints. The influence of fixation of the tibiotarsal joint on the neuromuscular synapse and the weight of the soleus and tibialis anticus muscles was studied on cats anesthetized with pentobarbital sodium. The joint was fixed in hyperflexion and hyperextension and in a position intermediate between these two. After immobilization in these three positions, these muscles show the same changes in neuromuscular transmission as are found in the tenotomized muscles. At high frequency of stimulation, there was a greater development of the third stage of neuromuscular fatigue, in relation to the first stage, than occurred in the central muscles. The immobilized muscle resembles tenotomized muscles also in being less sensitive to curare. Fixation in hyperflexion up to fourteen days causes an increase in the weight of the soleus and a decrease in the weight of the tibialis; fixation in hyperextension causes a decrease in the weight of the soleus and an increase in the weight of the tibialis. In the discussion, the hypothesis is presented that in immobilization, as in tenotomy, the abnormal tension to which muscle is exposed causes neuromuscular changes by a reflex mechanism.

Phosphorus Metabolism.—Bollman and Flock [788] present experiments to show that the changes in the phosphates of muscle after tourniquet shock are those of autolyzing muscle. Adenosine triphosphate almost disappears after three hours, and phosphocreatine is almost completely hydrolyzed in one hour. The inorganic phosphates of muscle rapidly increase to a maximum in about four hours. The total of the acid-soluble phosphates is not changed. If blood flow is restored within three hours, there is resynthesis of adenosine triphosphate and phosphocreatine and a decrease in inorganic phosphates. Fatal shock does not develop even if large amounts of muscle have been occluded.

Sacks [789] studied the effects of prolonged activity, recovery from activity and administration of glucose on the metabolism of phosphorus compounds of muscle, using radioactive phosphorus as a tracer substance.

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787. Thomsen, P., and Luco, J. V.: Changes of Weight and Neuromuscular Transmission in Muscles of Immobilized Joints, J. Neurophysiol. **7**:245-251 (July) 1944.

788. Bollman, J. L., and Flock, E. V.: Changes in Phosphate of Muscle During Tourniquet Shock, Am. J. Physiol. **142**:290-297 (Sept.) 1944.

789. Sacks, J.: Some Factors Influencing Phosphate Turnover in Muscle, Am. J. Physiol. **142**:621-626 (Nov.) 1944.

The principal observations were that prolonged activity does not influence either the uptake of radioactive phosphorus or its distribution between the various phosphorus compounds. Recovery from such activity does increase the turnover of phosphorus significantly, especially in the post-absorptive state. The administration of glucose to the animal in a post-absorptive state depresses the turnover of phosphocreatine and adenosine triphosphate but does not influence the turnover of glucose-6-phosphate.

Meyer and Meyer [790] attempted a study on the exact nature of vitamin C deficiency on inflammatory conditions. The pathologic processes involved in the healing of staphylococcic abscesses in scorbutic guinea pigs were found to be quite different from those in normal control animals. In the initial reaction surrounding the inoculation, the appearance of macrophages was normal. However, more bacteria appeared to be extracellular in the abscesses one, three and seven days after inoculation in the scorbutic animals than in the controls. The connective tissue reaction in the healing of sterile incisions was similar to that described by other workers. Proliferation of fibroblasts continued after it had ceased in the control animals, and no normal collagen was formed. The connective tissue and the abnormal hyalin-like intercellular substance which was formed were disorderly in arrangement, and the necrotic centers of the abscesses were not walled off. Studies of the blood showed anemia and low serum proteins in the scorbutic animals.

A preliminary report on the effect of roentgen rays on joints is presented by Horwitz and Dillman.[791] Six patients with nonspecific effusion of the joints involving the knee joint in human beings were treated by roentgen rays. Eight of the 9 patients responded favorably. In 3 cases biopsy of synovial membrane was done prior to treatment and in 2 cases after the treatment. There was disappearance of edema, a diffuse fibrosis and a thickening of the lumens of the smaller blood vessels. No tissue degeneration was noted. The effect of radiation in normal joints of dogs was studied, and there were no immediate untoward results. The authors will analyze the delayed effect of roentgen rays in subsequent reports.

Thrombin.—Ingraham and Bailey [792] discuss the two products thus far prepared from the purified fractions of human fibrinogen and throm-

790. Meyer, E., and Meyer, M. B.: Pathology of Staphylococcus Abscesses in Vitamin C-Deficient Guinea Pigs, Bull. Johns Hopkins Hosp. **74**:98-117 (Feb.) 1944.

791. Horwitz, T., and Dillman, M. A.: Effect of Roentgen Rays on Joint Effusions in Certain Nonspecific Articular Lesions in Humans, and on Normal Joints of Dogs: Preliminary Report, Am. J. Roentgenol. **51**:186-201 (Feb.) 1944.

792. Ingraham, F. D., and Bailey, O. T.: Clinical Use of Products of Human Plasma Fractionation: Use of Products of Fibrinogen and Thrombin in Surgery, J. A. M. A. **126**:680-685 (Nov. 11) 1944.

bin and their several uses: fibrin foam, which is used with a solution of thrombin as an absorbable hemostatic agent, and fibrin film, which has been used as a dural substitute and in the prevention of meningocerebral adhesions. Extensive clinical use of fibrin foam in neurosurgical and general surgical problems, including hemophilia, is discussed. The authors also discuss the limited use of solutions of fibrinogen and thrombin in special situations in which clot in situ is desirable. Method and ease of application are discussed.

Preface

IN THE preparation of this review of orthopedic surgery for 1944 the titles of 1,434 articles of orthopedic interest were selected from the *Quarterly Cumulative Index Medicus* for 1944. The number of articles reviewed and presented in this year's "Progress" is 821. This is a larger number of articles than that selected for 1943 but is still below the average for previous years. The increase in the number of articles over that of 1943 is due to the increase in the number of reports from the general hospitals of the armed services. As in the past, each editor has selected the articles for his section which he thinks represent the most progress and have the greatest scientific interest. The chairman of the editorial board has reviewed the material prepared for each section and has made certain additions and changes which seemed indicated to standardize the publications.

On account of the difficulties under which many of the editors have been working, the reviews of some of the sections have been slower in being returned to the chairman of the editorial board, and, as was true in the past two years, it was found impossible to send the whole "Progress" to the ARCHIVES at one time. This has necessitated a slight change in the order of publication of the sections. The preface could not be written until all sections had been submitted. In spite of the difficulties encountered in getting reprints, it is hoped that the quality of the reviews is up to standard and that the publication will prove as valuable to its readers as the "Progress" of previous years.

The members of the editorial board wish to thank again the physicians not members of the American Academy of Orthopaedic Surgeons who have rendered such valuable assistance in the preparation of the material for the various sections.

Special thanks are rendered to Dr. J. A. Toomey, of Cleveland, for editing the research portion of the section on "Poliomyelitis" and to Dr. Robert L. Bennett, of Warm Springs, Ga., for editing the physical therapy portion of the section on "Poliomyelitis."

The following physicians acted as assistants to members of the editorial board:

Dr. Ghormley: Dr. A. R. Pils, Dr. F. L. Flashman, Dr. T. Norley and Dr. W. O. Starks.

Dr. Steindler: Dr. F. E. Thornton, Dr. A. L. Glassman, Dr. W. H. Clarke, Dr. J. L. LeNoir, Dr. N. Kaplan, Dr. I. Ponseti, Dr. William Nelson, Dr. J. E. Kaufman, Dr. A. J. Langan, Dr. A. C. M. Bitar and Dr. A. L. Leveton.

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Dr. Myerding: Dr. W. M. Ashe, Dr. Luis Bravo, Dr. F. L. Flashman, Dr. R. Goyanna, Dr. R. Lopez-Kruger, Dr. Arnulf R. Pils and Dr. W. O. Starks.

Dr. Raney: Dr. H. H. Kuhn and Dr. Howard J. Schaubel.

Dr. White and Dr. Frankel: Dr. J. H. Turkell.

Both style and editorial comments have again been left to the discretion of the editors except for a few changes made by the chairman. It should be stated again, however, as in the preface of the "Progress" of previous years: "If the reader or author of any article does not agree with the editorial comment, the editorial board hopes that he will think of the remark as only one man's impression and as in no way representing the opinion of the entire editorial board" or of the American Academy of Orthopaedic Surgeons.

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